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Technical and Extension Series

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

COCHIN, INDIA

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the Fishery Data Centre and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

Abbreviation — *Mar. Fish. Infor. Serv. T & E Ser.*, No. 51 : 1983

CONTENTS

LIST OF TITLES

MARINE FISHERIES INFORMATION SERVICE T & E SERIES NO. 1 — 50

No. 34. January 1982

No. 35. February 1982

No. 36. March 1982

No. 37. April 1982

No. 38. May 1982

No. 39. June 1982

No. 40. July 1982

SUBJECT INDEX

AUTHOR INDEX

RECORD PRODUCTION OF MILKFISH FROM PONDS DEVELOPED IN SANDY BEACH AT CALICUT

The milkfish, *Chanos chanos*, a hardy, euryhaline and fast growing species was cultured to study the production as well as survival rates in the pump-fed, polyethylene film lined ponds developed on sandy beach at Calicut Research Centre of CMFRI from July 1982 to February 1983. In experiments conducted in 0.20 ha ponds a production of 1819 kg/ha/169 days (3927 kg/ha/year) in a monoculture pond, 1308.9 kg/ha/169 days (2825 kg/ha/year) in a polyculture pond with prawn *Penaeus indicus* and 1007.4 kg/ha/211 days (1741 kg/ha/year) in a mixed culture pond with prawn, *P. indicus* and fish *Etroplus suratensis* was obtained.

The maximum survival rate was 87.1% in monoculture pond, 74.4% in polyculture pond and 48.9% in mixed culture pond. In milkfish stocked at 18 mm size brought from Mandapam in the east coast, maximum growth of 361 mm in length and 357 g in weight was observed at harvest after 169 days of stocking. The fishes were fed with an artificial feed made out of coconut oil cake, ground nut oil cake and rice bran mixed in the ratio 1 : 1 : 1 at the rate of 10% of the body weight.

S. LAZARUS AND K. NANDAKUMARAN

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3. An annotated bibliography on the breeding habits and development of fishes of the Indian region.
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K. Alagarswamy, R.S. Lalmohan D.B. James and K.K. Appukuttan

5. Bibliography of the Indian Ocean, 1968 (With a supplement for 1962-1967).
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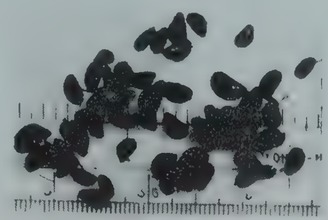

LABORATORY PRODUCTION OF SEED OF GREEN MUSSEL *PERNA VIRIDIS*

Adult mussels *(Perna viridis)* with mature gonad were induced to spawn at the Kovalam Field Laboratory of CMFRI by subjecting them to thermal stimulation. The mussels were kept at 18° - 20°C for half an hour and transferred quickly to sea water at 30° - 32°C. Within an hour, spawning occurred and the orange coloured eggs settled at the bottom of the tank.

The fertilized eggs measuring 45 - 50μ in diameter were washed well and allowed to develop in a 200-1 fibre glass tank containing pure sea water. The straight-hinge or D-shape larvae, measuring 65 - 70μ, were obtained in about 24 hours after fertilization. The larvae were screened through 41 u bolting silk and transferred to a 1000-1 larval rearing tank. The larval density was adjusted to 5000 larvae per litre. From the third day onwards the larvae were fed with a mixed microalgal culture containing *Chaetoceros* sp., *Skeletonema* sp. and other every minute algal cells. Aeration was provided to maintain oxygen level and also to keep the larvae and the algal cells in suspension. Half the quantity of water in the rearing tank was changed on alternate days.

The larvae passed through various development stages, namely umbo, eyed stage and pediveliger stage and attained a length of 280 - 300 u on the 15th day after fertilization. The pediveliger possessed a well developed foot, with which it started crawling and exploring the substratum, a pair of dark eye spot, 4-5 rudiments of gills and degenerating velar lobe. Experimental spat collectors such as tile, velon screen, frayed nylon rope, byssal threads of green mussel, glass wool and shells of oyster and mussel were introduced in the tank. First spatfall was observed on the 16th day and continued for about a week. Intense spatfall at 2-8 spat per sq. cm was obtained on glass wool, byssal threads and tiles. The length of a just settled spat was 320μ. Posterior elongation of the shell took place when the larvae were 22 days old with a length of 390 - 420μ and possessed 6-7 gill filaments. At the end of one month (July 1983) the spat measured 1.25-1.50 mm in length and had 3-4 patches of green colour along the margin of the shell. The spat usually ascended the wall of the tank and congregated at the water level. They attained a length of 3.5-4.0 mm in about 45 days.

For the first time in India the sea mussel has been bred successfully in the laboratory. This paves the way to further advances in the development of technology for large-scale production of mussel seed in hatchery.

K. RANGARAJAN

Compiled and prepared by M.J. George, G. Subbaraju, S.K. Dharmaraja & E. Johnson
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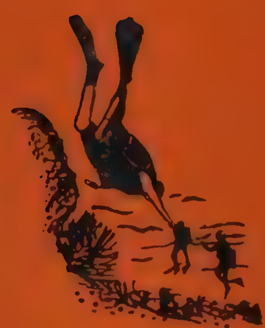

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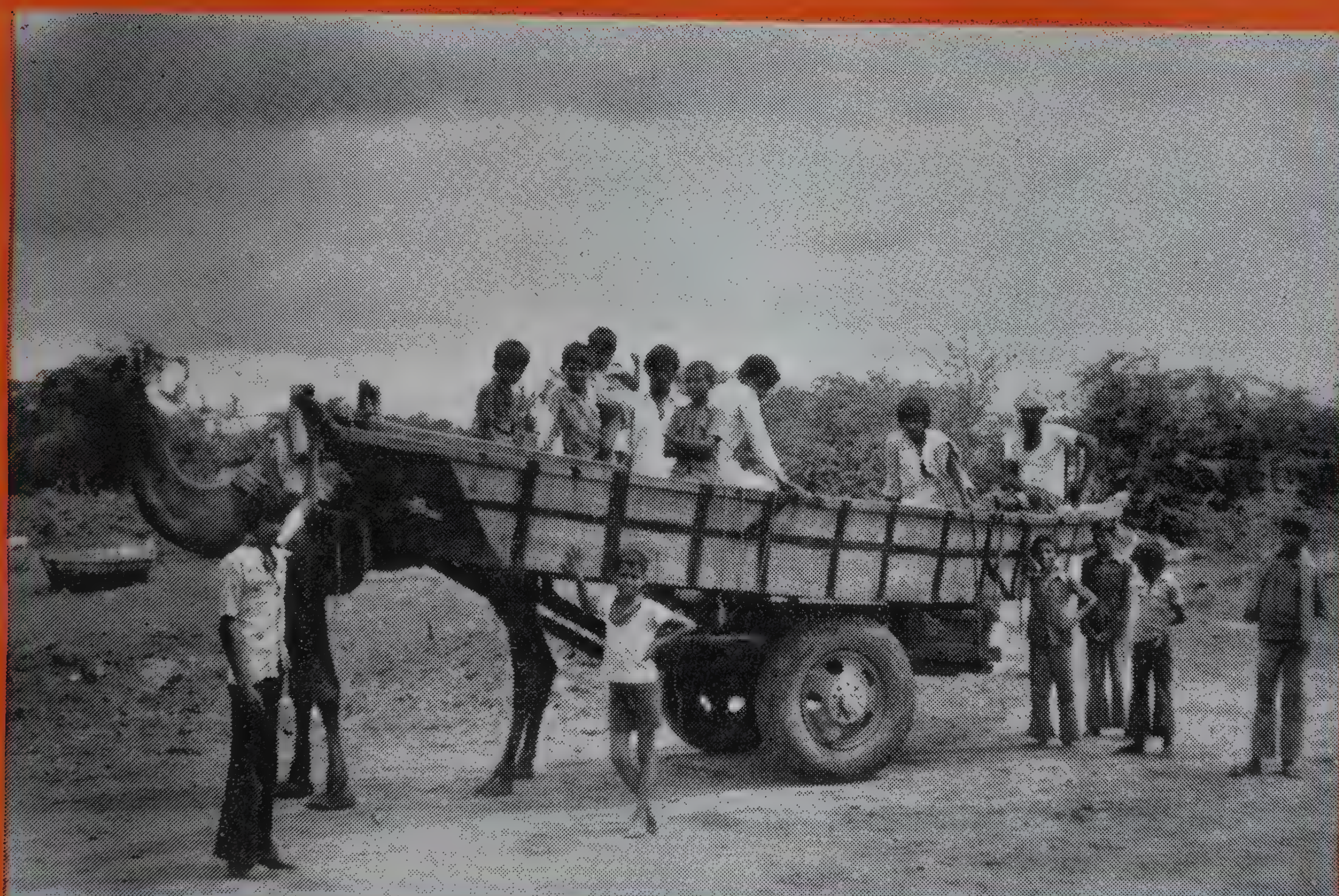

No. 52

AUGUST 1983

Technical and Extension Series

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

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CONTENTS

Cover photo: Transportation of fishing craft on camel cart in Gujarat. (courtesy: J. P. Karbhari

TRENDS IN MARINE FISH PRODUCTION IN INDIA — 1982-83*

The total marine fish production in India during the financial year 1982–83[1] was estimated at 14.15 lakh tonnes as compared to 14.21 lakh tonnes recorded during the previous year 1981–82, showing a marginal decline of about 6,000 tonnes. Barring the states of West Bengal, Karnataka and Gujarat where there was a marked decline, the total marine fish production increased in all other maritime states of India (Table 1). While the landings increased significantly in the states of Andhra Pradesh, Pondicherry, Kerala and Andamans there was only a marginal increase in Orissa, Tamil Nadu, Goa and Maharashtra.

Table 1. *Statewise total marine fish production in India during the years* 1982–83 *and* 1981–82 *(In tonnes)*

Sl.No.	State	1982–83	1981–82
1.	West Bengal	22,444	28,116
2.	Orissa	33,490	32,859
3.	Andhra Pradesh	1,26,004	1,07,786
4.	Tamil Nadu	2,35,953	2,35,423
5.	Pondicherry[2]	12,985	10,449
6.	Kerala	3,48,443	3,04,808
7.	Karnataka	1,27,968	1,62,962
8.	Goa[3]	35,874	34,995
9.	Maharashtra	2,67,527	2,56,369
10.	Gujarat	1,96,437	2,41,640
11.	Andamans	4,284	1,919
12.	Lakshadweep	3,810	3,907
	TOTAL	14,15,219	14,21,233

Pelagic and demersal group of fishes

In Table 2 the specieswise composition of total marine fish landings in India is shown. The species were grouped into pelagic and demersal. The pelagic group of species comprises wolf herring, oil sardine, other sardines, hilsa shad, other shads, anchovies, other clupeoids, Bombay duck, half beaks, full beaks, flying fishes, ribbon fishes, carangids, mackerel, seer fishes, tunnies, bill fishes, baracudas, mullets and unicorn cod. Elasmobranchs, eels, catfishes, lizard fishes, perches, goat fishes, threadfins, croakers, silver bellies, big jawed jumper, pomfrets, flatfishes, prawns, lobsters, crabs, stomatopods and cephalopods form the demersal group. For the purpose of comparison estimated specieswise composition of landings in 1981–82 and calendar year 1982 are given in Tables 3 and 4. The statewise break-up of pelagic and demersal group of fishes is shown in Table 5.

Table 5. *Statewise break-up of the landings of pelagic and demersal group of species during* 1982–83 *(In tonnes)*

Sl. No.	State	Pelagic	Demersal	Total
1.	West Bengal	9,301	13,143	22,444
2.	Orissa	14,639	18,851	33,490
3.	Andhra Pradesh	63,529	62,475	1,26,004
4.	Tamil Nadu	92,259	1,43,694	2,35,953
5.	Pondicherry	7,294	5,691	12,985
6.	Kerala	2,40,734	1,07,709	3,48,443
7.	Karnataka	77,264	50,704	1,27,968
8.	Goa	12,938	22,936	35,874
9.	Maharashtra	94,898	1,72,629	2,67,527
10.	Gujarat	78,931	1,17,506	1,96,437
11.	Andamans	2,617	1,667	4,284
12.	Lakshadweep	517	3,293	3,810
	TOTAL	6,94,921	7,20,298	14,15,219

From Table 5, it is seen that Kerala accounted for the highest catch of pelagic group of species during 1982–83 followed by Maharashtra, Tamil Nadu, Gujarat Karnataka and Andhra Pradesh in the order of abundance. As regards demersal group of fishes, Maharashtra accounted for the maximum followed by Tamil Nadu, Gujarat, Kerala, Andhra Pradesh and Karnataka. Figs 1 and 2 show the comparative landings of oil sardine, Bombay duck, anchovies, other sardines, ribbon fishes and mackerel belonging to the pelagic group and penaeid prawns, croakers, silver bellies, elasmobranchs, cat fishes and non-penaeid prawns of demersal group of fishes during 1982–83 and 1981–82.

1. From 1982 onwards the marine fish production in Inida is furnished on a financial year basis and accordingly the figures for the period from April 1982 to March 1983 are furnished. This has been given effect to meet the requirements of the various central and state Governments and other end users.

2. Excluding Mahe and Yenam which are included in Kerala and Andhra Pradesh respectively.

3. Excluding Daman and Diu which are included in Gujarat.

N.B:- For Andamans and Lakshadweep the figures were obtained from the Governments of the respective Union Territories.

* Prepared by Fishery Resources Assessment Division.

Table 2. *Estimated marine fish landings in India during 1982–83 (in tonnes)*

Sl.No.	Name of fish	West Bengal	Orissa	Andhra Pradesh	Tamil Nadu	Pondi-cherry	Kerala	Karna-taka	Goa	Maha-rashtra	Gujarat	Anda-mans	Laksha-dweep	Total
1.	Elasmobranchs													
	a. Sharks	369	1,384	5,818	3,405	104	4,260	4,593	643	8,383	10,173	32	203	39,367
	b. Skates	42	9	343	467	—	65	8	—	1,865	979	1	—	3,779
	c. Rays	499	133	1,706	11,267	391	1,309	235	175	2,886	3,322	15	18	21,956
2.	Eels	22	78	474	97	1	21	—	12	4,232	3,195	—	—	8,132
3.	Cat Fishes	3,752	3,240	3,648	4,295	19	9,922	10,223	2,292	11,300	12,111	38	—	60,840
4.	Clupeoids													
	a. Wolf herring *(chirocentrus)*	1,057	1,012	1,410	2,369	111	1,166	370	73	3,957	3,307	23	—	14,855
	b. Oil sardine	—	—	—	1,094	—	1,59,488	35,501	5,220	322	—	—	—	2,01,625
	c. Other sardines	24	4,528	13,161	25,255	1,809	8,488	2,861	1,183	799	—	1,299	—	59,407
	d. Hilsa shad *(Hilsa ilisha)*	1,128	1,079	187	164	1	108	15	—	482	153	—	—	3,317
	e. Other shads *(other Hilsa)*	78	348	2,917	4,262	56	—	46	—	1,524	4,048	18	—	13,297
	f. Anchovies													
	Coilia	312	327	216	261	—	—	3	1	8,509	5,483	—	—	15,112
	Setipinna	672	620	466	18	—	—	8	—	—	—	—	—	1,784
	Stolephorus (Anchoviella)	57	785	4,282	9,539	387	14,134	11,088	23	158	—	220	—	40,673
	Thrissina	—	—	—	—	—	—	—	—	—	—	—	—	—
	Thtyssa (Thrissocles)	58	186	3,767	4,488	410	957	973	2,557	2,454	4,655	1	—	20,506
	g. Other clupeoids	1,924	1,708	4,503	6,082	372	3,313	903	236	3,343	4,109	—	—	26,493
5.	Bombay duck *(Harpadon nehereus)*	1,500	179	1,463	8	2	—	—	—	48,974	38,296	—	—	90,422
6.	Lizard fishes *(Saurida & Saurus)*	—	525	1,591	1,752	243	5,466	495	354	1,906	650	—	—	12,982
7.	Half beaks & full beaks *(Hemirhamphus & Belone)*	—	1	11	838	196	1,054	249	10	158	1	26	84	2,628
8.	Flying fiishes	—	9	2	1,611	175	1	—	—	1	—	9	24	1,832
9.	Perches													
	a. Rock cods	11	9	22	1,649	27	311	21	5	348	108	—	—	2,511
	b. Snappers	—	23	646	1,293	3	49	—	7	17	164	—	—	2,202
	c. Pig-face breams	—	—	1	2,579	4	95	—	—	7	—	—	—	2,686
	d. Threadfin breams	—	868	2,126	3,681	660	9,072	1,763	1,094	5,399	1,201	—	—	25,864
	e. Other perches	40	762	4,834	4,486	794	1,253	383	407	1,802	1,281	502	219	16,763
10.	Goat fishes (Red mullets)	—	174	1,559	1,768	100	373	7	—	1,924	—	—	26	5,931
11.	Threadfins *(Polynemids)*	104	27	1,896	374	25	131	—	—	473	3,542	2	—	6,574
12.	Croakers (Sciaenids)	1,185	4,003	8,630	16,622	559	3,851	2,776	2,503	2,503	24,988	—	—	82,170
13.	Ribbon fishes	113	498	8,886	6,254	68	11,046	1,308	1,063	17,053	7,197	21	—	47,597
14.	Carangids													
	a. Horse Mackerel	—	54	510	13	—	815	380	—	164	321	—	—	2,257
	b. Scads	—	225	3,712	703	1,618	2,708	46	2	21	26	—	—	9,061
	c. Leather-jackets *(Chorinemus)*	408	97	1,379	456	27	388	297	60	617	2,677	—	—	6,406
	d. Other carangids	5	209	2,502	7,585	660	9,843	2,302	965	2,522	324	167	204	27,288
15.	Silver bellies *(Leiognathus & Gazza)*	78	1,234	6,832	45,705	621	9,093	4,015	1,538	99	—	907	—	70,122
16.	Big-jawed jumper *(Lactarius)*	—	12	735	537	13	1,840	1,045	1,029	3,169	5,905	—	—	14,285
17.	Pomfrets													
	a. Black pomfret	419	507	1,814	692	100	1,909	1,970	341	2,883	2,239	4	—	12,878
	b. Silver pomfret	4,176	2,163	1,821	408	14	2,463	1,220	67	12,748	10,554	20	—	35,654
	c. Chinese pomfret	71	9	153	74	—	9	20	—	13	—	—	—	349
18.	Mackerels													
	a. Indian mackerel	2	974	4,182	3,738	737	9,270	5,304	66	344	—	345	—	24,962
	b. Other mackerels	—	—	—	6	1	—	—	—	—	—	—	—	7
19.	Seer fishes													
	a. *S. commerson*	818	217	3,218	5,032	106	3,301	4,256	107	2,610	—	85	49	19,799
	b. *S. guttatus*	271	948	3,817	507	2	1,860	1,861	527	1,159	2,544	83	48	13,627
	c. *S. lineolatus*	—	13	—	85	—	38	40	—	—	—	—	—	176
	d. *Acanthosybium* Sp.	—	—	—	9	—	—	—	—	—	—	—	—	9

Contd.

Sl.No.	Name of fish	West Bengal	Orissa	Andhra Pradesh	Tamil Nadu	Pondicherry	Kerala	Karnataka	Goa	Maharashtra	Gujarat	Andamans	Lakshadweep	Total
20.	Tunnies													
a.	*E. affinis*	—	292	817	2,666	20	4,414	2,205	—	152	228	—	27	10,821
b.	*Auxis* spp.	—	9	—	500	—	1,409	31	—	4	—	—	—	1,953
c.	*K. pelamis*	—	3	—	1	—	49	—	—	—	—	31	2,055	2,139
d.	*T. tonggol*	—	—	—	4	—	7	—	—	—	—	—	—	11
e.	Other tunnies	—	1	124	302	34	426	7	6	2,968	62	9	552	4,491
21.	Bill fishes	—	5	362	241	87	272	47	—	165	889	5	41	2,114
22.	Barracudas (*Sphyraena*)	—	23	173	1,621	40	543	83	28	217	262	47	10	3,047
23.	Mullets (*Mugil*)	86	4	459	449	..	32	9	76	27	1,290	133	—	2,565
24.	Unicorn cod (*Bregmaceros*)	—	—	—	—	—	—	—	—	64	—	—	—	64
25.	Flat fishes													
a.	Halibut (*Psettodes erumei*)	—	—	34	339	2	116	12	—	617	264	—	—	1,384
b.	Flounders	—	—	85	4	—	6	—	2	—	—	—	—	97
c.	Soles	4	395	807	2,833	291	12,160	1,666	735	2,703	1,985	—	—	23,579
26.	Crustaceans													
a.	Penaeid prawns	288	2,031	8,706	13,049	265	32,288	7,732	5,914	34,814	12,316	64	—	1,17,467
b.	Non penaeid prawns	682	226	4,871	410	9	33	—	—	44,799	5,064	—	—	56,094
c.	Lobsters	—	35	10	325	33	110	1	18	534	321	2	—	1,389
d.	Crabs	72	118	1,491	10,972	982	371	409	546	486	5,533	20	—	21,000
e.	Stomatopods	25	268	412	1,241	8	5,360	6,520	3,732	3,254	4,110	—	—	24,930
27.	Cephalopods	21	232	424	3,689	117	3,206	945	218	5,203	2,941	—	20	17,016
28.	Miscellaneous	2,071	671	1,989	15,779	681	8,171	11,716	2,039	5,752	7,619	155	230	56,873
	TOTAL	22,444	33,490	1,26,004	2,35,953	12,985	3,48,443	1,27,968	35,874	2,67,527	1,96,437	4,284	3,810	14,15,219

Table 3. *Estimated marine fish landings in India during* 1981–82 (in tonnes)

Sl.No.	Name of fish	West Bengal	Orissa	Andhra Pradesh	Tamil Nadu	Pondicherry	Kerala	Karnataka	Goa	Maharashtra	Gujarat	Andamans	Lakshadweep	Total
1.	Elasmobranchs													
a.	Sharks	514	2,395	2,999	2,594	180	3,747	3,354	362	8,359	8,565	16	190	33,275
b.	Skates	368	—	140	116	—	347	—	—	229	462	—	—	1,662
c.	Rays	190	824	1,090	10,167	219	1,320	237	61	2,244	4,423	10	23	20,808
2.	Eels	21	32	294	190	12	7	7	6	2,807	2,740	—	—	6,116
3.	Cat Fishes	9,921	5,091	2,591	5,487	93	9,326	8,598	1,673	10,820	11,309	21	—	64,930
4.	Clupeoids													
a.	Wolf herring	360	1,244	1,245	2,220	83	1,063	154	55	3,910	3,651	21	—	14,006
b.	Oil sardine	—	—	—	295	—	1,72,230	73,327	9,399	393	—	—	—	2,55,644
c.	Other sardines	—	4,251	14,652	22,741	1,582	7,091	5,290	1,493	433	—	277	—	57,810
d.	Hilsa shad	2,683	2,169	32	113	—	11	1	1	685	17	—	—	5,712
e.	Other shads	37	23	1,688	3,884	103	15	52	12	1,277	7,638	18	—	14,747
f.	Anchovies													
	Coilia	177	59	57	277	6	—	—	—	15,502	3,622	—	—	19,700
	Setipinna	439	179	186	285	70	—	2	—	—	—	—	—	1,161
	Stolephorus	5	132	11,051	7,681	268	4,674	7,430	86	83	—	214	—	31,624
	Thrissina	—	—	—	—	—	—	—	—	—	—	—	—	—
	Thryssa	110	338	2,421	6,249	515	682	207	517	1,452	2,277	—	—	14,768
g.	Other clupeoids	3,088	1,963	4,875	4,769	386	951	257	338	3,341	3,441	—	—	23,409
5.	Bombay duck	810	84	905	—	—	—	1	1	71,700	59,146	—	—	1,32,647
6.	Lizard fishes	—	76	845	1,741	241	5,648	418	663	1,335	523	—	—	11,490

Contd.

7. Half beaks & full beaks	1	1	63	823	56	673	120	—	80	—	18	103	1,938
8. Flying fishes	—	—	166	2,464	614	7	—	—	—	—	3	14	3,268
9. Perches													
a. Rock cods	—	178	41	1,008	15	269	10	1	107	188	—	—	1,817
b. Snappers	—	33	261	724	—	350	—	2	143	438	—	—	1,951
c. Pig-face breams	—	—	—	1,158	18	115	1	—	4	—	—	—	1,296
d. Threadfin breams	—	19	1,624	2,211	383	6,905	278	713	3,017	3,065	—	—	18,215
e. Other perches	28	110	3,505	3,040	493	1,533	107	529	180	2,457	246	253	12,481
10. Goat fishes	—	114	868	1,247	135	38	1	—	1,116	294	—	24	3,837
11. Threadfins	323	491	1,110	240	1	126	3	14	431	2,268	—	—	5,007
12. Croakers	224	2,100	6,893	19,994	324	2,747	1,655	1,546	16,343	34,840	—	—	86,666
13. Ribbon fishes	202	376	7,287	7,513	164	7,058	286	592	9,287	9,458	16	—	42,239
14. Carangids													
a. Horse Mackerel	—	236	411	147	—	235	981	113	120	688	—	—	2,931
b. Scads	—	47	3,302	1,320	162	1,518	—	—	—	—	—	—	6,349
c. Leather-jackets	60	33	495	827	10	617	241	5	406	2,873	—	—	5,567
d. Other carangids	—	144	1,447	8,154	1,569	4,931	1,827	672	860	157	167	103	20,031
15. Silver bellies	—	536	7,334	52,682	899	3,124	1,329	1,566	203	—	315	—	67,988
16. Big-jawed jumper	—	44	691	449	43	935	440	902	891	5,700	—	—	10,095
17. Pomfrets													
a. Black pomfret	54	416	1,393	617	103	538	71	96	2,095	2,832	1	—	8,216
b. Silver pomfret	3,115	2,487	1,453	449	9	868	172	10	15,850	19,229	8	—	43,650
c. Chinese pomfret	544	2	29	4	—	15	8	—	5	1	—	—	608
18. Mackerels													
a. Indian Mackerel	—	515	3,967	4,425	273	12,788	14,359	5,570	275	—	139	—	42,311
b. Other mackerels	—	—	—	—	4	—	—	—	—	—	—	—	4
19. Seer fishes													
a. *S. commerson*	1,186	579	1,269	4,438	50	2,163	1,947	248	1,646	—	64	28	13,618
b. *S. guttatus*	102	2,588	3,215	543	28	2,253	1,003	168	1,192	3,785	68	30	14,975
c. *S, lineolatus*	—	52	13	35	—	6	188	31	—	—	—	—	325
d. *Acanthocybium* Sp.	—	—	—	—	—	—	—	—	—	—	—	—	—
20. Tunnies													
a. *E. affinis*	—	227	201	2,966	10	5,235	2,324	48	240	627	—	30	11,908
b. *Auxis* spp.	—	—	—	126	—	1,446	1	—	—	—	—	—	1,573
c. *K. pelamis*	—	—	—	23	—	1	—	—	7	—	14	2,285	2,330
d. *T. Tonggol*	—	—	—	—	—	64	—	—	—	14	—	—	78
e. Other tunnies	—	14	76	470	43	192	—	49	1,127	113	20	615	2,719
21. Bill fishes	—	1	210	178	20	142	3	—	114	—	—	19	687
22. Baracudas	—	12	246	1,190	55	903	14	38	12	454	57	9	2,990
23. Mullets	1	—	178	373	9	117	1	104	25	1,309	72	—	2,189
24. Unicorn cod	—	—	—	—	—	—	—	—	19	—	—	—	19
25. Flat fishes													
a. Halibut	—	1	72	217	11	196	—	—	10	486	—	—	993
b. Flounders	—	—	1,037	32	—	—	—	—	65	—	—	—	1,134
c. Soles	2	35	1,112	1,912	183	4,564	743	607	2,113	3,951	—	—	15,222
26. Crustaceans													
a. Penaeid prawns	299	1,326	6,714	15,582	312	21,809	5,313	2,556	21,925	11,250	26	—	87,112
b. Non-penaeid prawns	848	55	1,577	803	19	142	4	—	43,002	4,514	—	—	50,964
c. Lobsters	—	6	5	207	7	59	48	12	583	921	2	—	1,850
d. Crabs	45	132	1,012	11,164	223	218	1,171	624	203	10,286	20	—	25,098
e. Stomatopods	—	125	210	1,287	—	2,838	11,972	1,955	622	3,066	—	—	22,075
27. Cephalopods	—	73	589	2,463	52	2,904	301	56	2,074	2,570	—	15	11,097
28. Miscellaneous	2,359	891	2,639	13,109	394	2,054	16,705	1,501	5,407	5,992	86	166	56,303
TOTAL	28,116	32,859	1,07,786	2,35,423	10,449	30,808	1,62,962	34,995	2,56,369	2,41,640	1,919	3,907	14,21,233

Table 4. *Estimated marine fish landings in India during the calendar year 1982 (in tonnes)*

Sl.No.	Name of fish	West Bengal	Orissa	Andhra Pradesh	Tamil Nadu	Pondi-cherry	Kerala	Karna-taka	Goa	Maha-rashtra	Gujarat	Anda-man	Laksha-dweep	Total
1.	Elasmobranchs													
	a. Sharks	523	1,986	4,673	2,890	99	4,415	4711	454	8,887	10,880	25	221	39,764
	b. Skates	210	4	231	448	—	357	—	—	1,111	984	—	—	3,345
	c. Rays	503	347	1,543	10,444	292	1,571	347	168	2,377	3,583	13	19	21,207
2.	Eels	36	83	529	155	2	19	7	15	3,843	2,790	—	—	7,479
3.	Cat fishes	9,075	3,995	3,182	6,048	20	9,532	10,253	1,941	10,919	12,662	37	—	67,664
4.	Clupeoids													
	a. Wolf herring	611	1,141	1;245	2,666	117	1,060	394	74	4,357	3,537	20	—	15,222
	b. Oil sardine	—	—	—	1,084	—	1,43,215	55,126	5,518	351	—	—	—	2,05,294
	c. Other sardines	4	4,112	13,758	23,291	1,383	7,388	3,151	963	475	—	971	—	55,496
	d. Hilsa shad	1,083	1,125	148	174	1	39	13	—	432	153	—	—	3,168
	e. Other shads	79	318	2,478	4,011	103	—	45	—	1,330	4,990	21	—	13,375
	f. Anchovies	—	—	—	—	—	—	868	—	10	—	—	—	878
	Coilia	243	26	231	172	—	—	11	1	10,408	5,231	—	—	16,323
	Setipinna	584	292	469	18	—	—	7	—	—	—	—	—	1,370
	Stolephorus	45	325	5,934	9,697	384	13,597	11,480	22	81	—	259	—	41,824
	Thrissina	—	—	—	—	—	—	—	—	—	—	—	—	—
	Thryssa	107	210	2,822	4,912	458	969	934	2,138	1,967	4,795	—	—	19,312
	g. Other clupeoids	2,563	1,592	4,984	5,540	492	3,095	603	271	2,983	3,901	—	—	26,024
5.	Bombay duck	1,663	181	1,534	2	—	—	1	—	45,162	37,933	—	—	86,476
6.	Lizard fishes	—	330	1,658	1,932	240	5,480	250	403	1,160	807	—	—	12,260
7.	Half beaks & full beaks	—	—	48	825	188	1,005	279	10	157	1	29	87	2,629
8.	Flying fishes	—		168	1,617	175	1	—	—	1	—	9	25	1,996
9.	Perches													
	a. Rock cods	11	187	35	1,294	32	285	18	5	334	111	—	—	2,312
	b. Snappers	—	37	330	1,199	3	337	—	5	43	170	—	—	2,124
	c. Pig-face breams	—	—	—	2,256	3	114	—	—	7	—	—	—	2,380
	d. Threadfin breams	—	831	2,457	3,737	528	9,223	296	437	4,410	1,754	—	—	23,673
	e. Other perches	41	735	4,316	3,911	736	1,218	204	461	922	1,402	361	230	14,537
10.	Goatfishes	—	107	1,520	1,457	108	244	1	—	1,720	—	—	27	5,184
11.	Threadfins	133	92	2,043	379	22	118	3	—	482	3,573	—	—	6,845
12.	Croackers	1,072	3,713	8,779	2,2029	561	3,581	2,326	2,298	15,926	26,962	—	—	87,247
13.	Ribbon fishes	181	443	6,795	6,365	108	11,034	1,062	1,035	12,355	9,474	23	—	48,875
14.	Carangids													
	a. Horse Mackerel	—	231	708	150	—	921	380	—	196	330	—	—	2,916
	b. Scads	—	59	2,714	643	1,599	2,076	46	2	21	26	—	—	7,186
	c. Leather-jackets	79	97	585	703	20	534	375	60	623	2,618	—	—	5,694
	d. Other carangids	4	202	2,426	6,158	713	9,160	1,865	1,368	1,799	169	151	214	24,229
15.	Silver bellies	24	1,133	5,132	52,577	538	8,730	2,417	1,011	169		937	—	72,668
16.	Big-jawed jumper	—	8	818	679	27	1,609	830	966	2,519	6,416	—	—	13,872
17.	Pomfrets	—	—	—	9	—	—	—	246	591	—	—	—	846
	a. Black pomfret	254	449	2,131	754	101	1,944	1,979	80	2,600	2,203	4	—	12,499
	b. Silver pomfret	3,504	2,291	1,870	521	14	2,288	1,077	37	13,631	11,025	20	—	36,278
	c. Chinese pomfret	65	4	151	73	—	13	20	—	118	1	—	—	345
18.	Mackerels													
	a. Indian mackerel	—	620	2,971	4,441	527	10,717	5,511	2,607	258	—	348	—	28,000
	b. Other mackerels	—	—	—	6	1	—	—	—	—	—	—	—	7
19.	Seer fishes													
	a. *S. commerson*	664	707	2,476	4,376	69	3,621	4,898	108	2,313	—	77	50	19.359
	b. *S. guttatus*	165	1,375	3,225	515	4	1,958	1,924	527	1,202	2,656	74	49	13,674
	c. *S. lineolatus*	—	40	—	81	—	38	4	—	1	1	—	—	163
	d. *Acanthocybium* Sp.	—	—	—	1	—	—	—	—	—	—	—	—	1

Contd.

20. Tunnies													
a. *E. affinis*	—	405	647	2,521	—	5,265	2,230	—	245	276	—	30	11,619
b. *Auxis spp.*	—	1	—	371	—	1,478	31	—	4	—	—	—	1,885
c. *K. pelamis*	—	2	—	5	—	50	—	—	—	—	28	2,314	2,399
d. *T. tonggol*	—	—	—	—	—	43	—	—	—	—	—	—	43
e. Other tunnies	—	1	169	317	52	445	7	6	2,943	82	7	622	4,651
21. Bill fishes	—	—	223	258	85	253	47	—	191	889	—	42	1,988
22. Barracudas	—	12	286	1,787	49	656	66	28	188	473	71	10	3,626
23. Mullets	75	—	396	511	4	33	8	64	27	1,234	123	—	2,475
24. Unicorn cod	—	—	—	—	—	—	—	—	69	—	—	—	69
25. Flat fishes													
a. Halibut	—	1	58	347	6	181	7	—	424	417	—	—	1,441
b. Flounders	—	—	74	7	—	—	—	2	5	—	—	—	88
c. Soles	3	272	720	2,909	225	11,422	1,373	617	2,549	2,609	—	—	22,699
26. Crustaceans													
a. Penaeid prawns	299	2,096	9,892	14,095	304	26,708	7,698	3,491	33,914	12,237	63	—	1,10,797
b. Non-penaeid prawns	884	222	4,637	367	16	65	—	—	40,809	4,148	—	—	51,148
c. Lobsters	—	38	8	312	27	94	49	24	727	483	2	—	1,764
d. Crabs	103	62	955	12,668	917	347	1,003	904	474	7,638	28	—	25,099
e. Stomatopods	12	115	295	2,096	6	4,023	9,930	3,504	2,397	5,141	—	—	27,519
27. Cephalopods	6	195	595	3,238	84	3,536	153	166	4,781	3,023	—	22	15,799
28. Miscellaneous	2,741	707	1,962	13,912	615	9,690	18,518	2,004	5,532	7,417	158	239	63,495
TOTAL	27,649	33,557	1,18,034	2,45,961	12,058	3,25,795	1,54,836	34,041	2,53,429	2,07,204	3,859	4,201	14,20,624

Table 6 (d). *Statewise landings of marine fish from mechanised and non-mechanised fishing crafts in Goa and Maharashtra during 1982–83 (In tonnes)*

	GOA							MAHARASHTRA						
	Mechanised fishing		Mechanised Power propulsion			Non-mechanised	Grand total	Mechanised fishing	Mechanised Power propulsion				Non-mechanised	Grand Total
Name of fish	Trawl net	Purse seine	Drift/gill net	Others	Total			Trawl net	Dol net	Drift/gill net	Hooks & lines	Total		
Oil sardine	—	1,640	—	—	1,640	3,580	5,220	87	—	—	—	87	235	322
Mackerel	—	52	—	3	55	11	66	64	—	4	—	68	276	344
Bombay duck	—	—	—	—	—	—	—	271	47,366	7	—	47,644	1,330	48,974
Croakers	2,197	41	2	—	2,240	263	2,503	12,093	1,666	684	78	14,521	2,532	17,053
Perches	1,292	98	7	—	1,397	116	1,513	7,288	38	10	7	7,343	230	7,573
Pomfrets	159	5	52		216	192	408	1,687	7,127	5,135		13,949	1,695	15,644
Tunnies	—	—	5	—	5	1	6	1,357	—	384	—	1,741	1,383	3,124
Penaeid prawns	5,860	7	1	—	5,868	46	5,914	28,804	4,275	143	—	33,222	1,592	34,814
Non-penaeid prawns	—	—	—	—	—	—	—	4,479	39,484	—	—	39,963	4,836	44,799
Others	12,974	4,094	695	72	17,835	2,409	20,244	58,343	17,279	7,387	453	83,462	11,418	94,880
TOTAL	22,482	5,937	762	75	29,256	6,618	35,874	1,10,473	1,17,235	13,754	538	2,42,000	25,527	2,67,527
No. of operations of units	75,139	7,599	9,756	90		64,690		1,85,152	2,20,284	87,484	2,201		4,11,121	

Statewise marine fish production

West Bengal

During 1982–83, the total marine fish landings in West Bengal were estimated at about 22,400 t. in comparison to about 28,000 t. recorded in 1981–82, showing a decline of about 5,600 t. This was due to reduced landings of cat fishes, hilsa shad, other clupeoids and seer fishes by about 6,200, 1,600,1,200 and 200 t. respectively. The landings of croakers, pomfrets, wolf herring and Bombay duck, however, showed an increase of 960, 950, 700 and 690 t. respectively.

Orissa

The total catch in Orissa during 1982–83 increased marginally to about 33,500 t. from 32,900 t. recorded in 1981–82. The landings of croakers, perches, anchovies, penaeid prawns and other sardines increased by about 1,900, 1,300, 1,200, 700 and 280 t. respectively. Cat fishes, elasmobranchs, other clupeoids and pomfrets, however, recorded lower landings by 1,900, 1,700, 260 and 230 t. respectively.

Andhra Pradesh

During 1982–83, the total marine fish landings in Andhra Pradesh was about 126,000 t as compared to about 108,000 t recorded in 1981–82, showing an increase of about 18,000 t (17%). This was due to higher landings of elasmobranchs, non-penaeid prawns, seer fishes, perches, penaeid prawns, croakers and ribbon fishes whose landings increased by about 3,600, 3,300, 2,500, 2,200, 2,000, 1,700 and 1,600 t respectively. The landings of anchovies, other sardines and silver bellies, however, declined by about 5,000, 1,500 and 500 t respectively.

Tamil Nadu

The total landings in Tamil Nadu during 1982–83 did not show much variation as compared to 1981–82, the respective figures being about 236,000 and 235,400 t. Perches, other sardines and elasmobranchs recorded higher landings, the increase being 5,500, 2,500 and 2,300 t respectively. The landings of silver bellies, croakers, penaeid prawns and carangids, however, showed decline, the reduction in their landings being 7,000, 3,400, 2,500 and 1,700 t respectively.

Pondicherry

An increase of about 2,500 t (24%) in the total landings was noticed in Pondicherry during 1982–83 as compared to 1981–82. Higher landings of crabs, perches, carangids, mackerel and other sardines were observed, the increase being about 760, 580, 560, 460 and 230 t respectively. The catch of anchovies, however, declined by about 60 t.

Kerala

During 1982–83, the total marine fish landings increased to about 348,000 t from about 305,000 t recorded in 1981–82, the quantum of increase being about 43,000 t (14%). The landings of penaeid prawns, anchovies, flat fishes, carangids, silver bellies and ribbon fishes showed an increase of about 10,500, 9,700, 7,500, 6,500, 6,000 and 4,000 t respectively. The catch of oil sardine and mackerel, however, showed a decline of about 12,700 and 3,500 t respectively.

Karnataka

The total landings in Karnataka during 1982–83 showed a substantial fall of about 35,000 t (21%) as compared to 1981–82. This was due to significant reduction in the catch of oil sardine and mackerel, the decrease in their landings being about 38,000 and 9,000 t respectively. Consequent to the failure of oil sardine and mackerel fisheries, reduction in the number of purse seine operations at Mangalore, Malpe, Ganguli and Bhatkal was observed. The landings of anchovies, seer fishes, penaeid prawns, cat fishes and thread fin breams, however, showed an increase of about 4,400, 3,000 2,400, 1,600 and 1,500 t. respectively.

Goa

During 1982–83, the total catch in Goa showed a marginal increase of about 900 t as compared to 1981–82. The salient feature of the fisheries of this state was that while mackerel and oil sardine recorded substantially lower catches, the reduction in their landings being about 5,500 and 4,200 t respectively, penaeid prawns, anchovies, croakers and catfishes recorded higher landings, the increase in their catch being about 3,400, 2,000, 1,000 and 600 t respectively.

Maharashtra

The total landings in Maharashtra during 1982–83 increased to about 268,000 t from about 256,000 t. recorded in 1981–82. The landings of penaeid prawns, threadfin breams, ribbon fishes, non-penaeid prawns, croakers and catfishes showed an increase of about 12,900, 2,400, 1,900, 1,800, 700 and 500 t respectively. Bombay duck and pomfrets, however, recorded lower

landings, the reduction in their landings being about 22,700 and 2,300 t respectively.

Gujarat

In Gujarat, the total landings during 1982–83 declined sharply by about 45,000 t (19%) as compared to 1981–82. This is mainly due to significant fall in the landings of Bombay duck, the reduction in the catch being about 21,000 t. Croakers, pomfrets, perches and ribbon fishes also recorded lesser landings by about 9,900, 9,300, 3,400 and 2,300 t. respectively. The landings of penaeid prawns, elasmobranchs, catfishes and non-penaeid prawns, however, showed an increase of about 1,100, 1,000, 800 and 600 t respectively.

Andamans

A significant increase of about 2,400 t in the total catch was noticed in Andamans during 1982–83 as compared to 1981–82. This was due to higher landings of other sardines, silver bellies, perches and mackerel, the increase in their catch being about 1,000, 600, 260 and 210 t respectively.

Lakshadweep

The total landings in Lakshadweep marginally declined by about 100 t during 1982–83 as compared to 1981–82. While the catch of tunnies and perches declined by about 300 and 30 t. respectively, the landings of carangids showed an increase of about 100 t.

Major groups of fishes

From Table 2, it is seen that oil sardine landings accounted for about 2.02 lakh t forming about 14.2% of the total all India landings during 1982–83. The landings of other major groups of species in the order of abundance of their catch are penaeid prawns (117,000 t-8.3%), Bombay duck (90,000 t-6.4%), croakers (82,000 t-5.8%), anchovies, (78,000 t-5.5%), silver bellies (70,000 t - 5.0%), elasmobranchs (65,000 t - 4.6%), catfishes (61,000 t - 4.3%), other sardines (59,000 t-4.2%), non-penaeid prawns (56,000 t - 4.0%), perches (50,000 t - 3.5%), pomfrets (49,000 t - 3.5%), ribbonfishes (48,000 t - 3.4%) and mackerel (25,000 t - 1.8%).

Pelagic group (Fig. 1)

1. Oil sardine

During 1982–83, the landings of oil sardine declined by about 54,000 t (21%), the respective figures for 1982–83 and 1981–82 being 2,02,000 and 2,56,000 t. This was due to reduced landings in the states of Karnataka, Kerala and Goa, the decrease in the catch of oil sardine in the above states being about 37,800, 12,700 and 4,200 t respectively. This was reflected in the poor catches of oil sardine in purse seiners in these states.

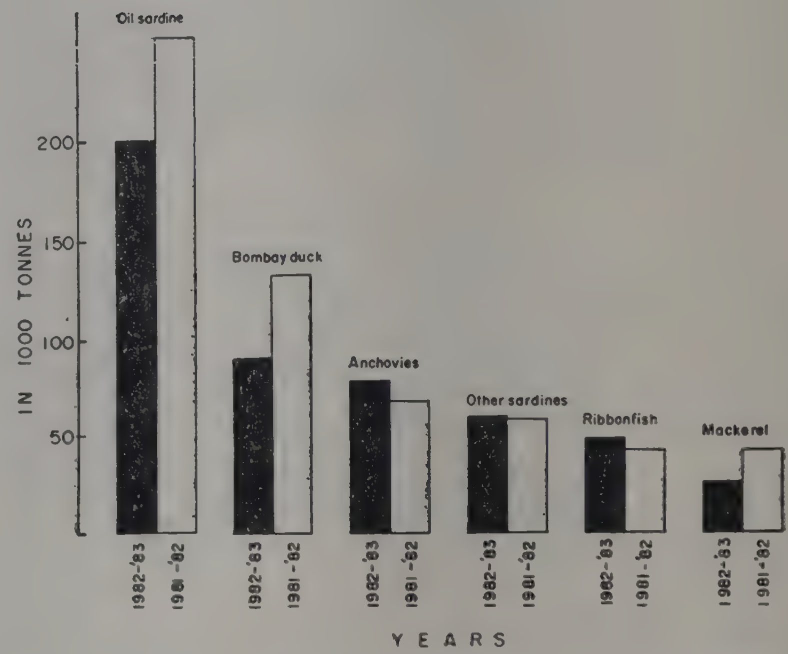

Fig. 1. Comparison of landings of major pelagic groups of fishes between 1981-82 and 1982-83.

2. Bombay duck

A decline to the tune of about 42,000 t (32%) in the landings of Bombay duck was noticed during 1982–83 as compared to 1981–82 the respective yields being about 90,000 and 1,33,000 t. Both Maharashtra and Gujarat accounted for lower landings, the decrease in the landings in these states being about 23,000 and 20,000 t respectively.

3. Anchovies

An increase of about 11,000 t (16%) was noticed in the catch of anchovies during 1982–83 as compared to 1981–82, the respective catch figures being about 78,000 and 67,000 t. An increase in the landings in the states of Kerala (9,700 t), Karnataka (4,400 t) and Goa (2,100 t) contributed to the total all India higher landings. In Andhra Pradesh, however, the yield of anchovies showed a substantial fall of about 5,000 t.

4. Other sardines

The landings of other sardines showed a marginal increase of about 1,600 t during 1982–83 as compared

to 1981–82, the respective yields being about 59,100 and 57,000 t. While the catch increased in the states of Tamil Nadu (2,500 t), Orissa (300 t) and Pondicherry (200 t), Andhra Pradesh recorded a lower catch, the decline being about 1,500 t.

5. Ribbon fishes

There was an increase in the landings of ribbon fishes to the tune of about 5,400 t during 1982–83 as compared to that of 1981–82 the respective landings being 47,000 and 42,200 t. While an increase in the landings was observed in the states of Kerala (4,000 t), Maharashtra (1,900 t) and Andhra Pradesh (1,600 t), a decline in the catches to the tune of about 2,300 t was noticed in Gujarat.

6. Mackerel

The landings of mackerel (25,000 t) during the year was the lowest ever recorded in the last one decade, the reduction in the catch during 1982–83 as compared to 1981–82, being 17,300 t. Decline was observed in the states of Karnataka, Goa and Kerala wherein mackerel forms a major fishery, the reduction in the catch in those states being about 9,100 t, 5,500 and 3,500 t, respectively.

Demersal group (Fig. 2)

Penaeid prawns

The landings of penaeid prawns during 1982–83 increased significantly by about 30,000 t (35%) as compared to 1981–82, the landings during the two years being about 117,000 and 87,000 t respectively. Higher landings were recorded in all the maritime states except West Bengal, Tamil Nadu and Pondicherry. A substantial increase in the catch was particularly noticed in the states of Maharashtra (13,000 t), Kerala (10,500 t), Goa (3,400 t), Karnataka (2,400 t), Andhra Pradesh (2,000 t) and Gujarat (1,100 t). In Tamil Nadu, however, there was a reduction in the landings to the tune of about 2,500 t.

Croakers

The landings of croakers declined to 82,200 t during 1982–83 from 86,700 t recorded during 1981–82, showing a marginal decline of about 4,500 t (5%). This was due to a decrease in the landings in the states of Gujarat (9,900 t) and Tamil Nadu (3,400 t). The yield, however, showed an increase in the states of Orissa (1,900 t.), Andhra Pradesh (1,700 t), Goa (960 t,) and Maharashtra (710 t).

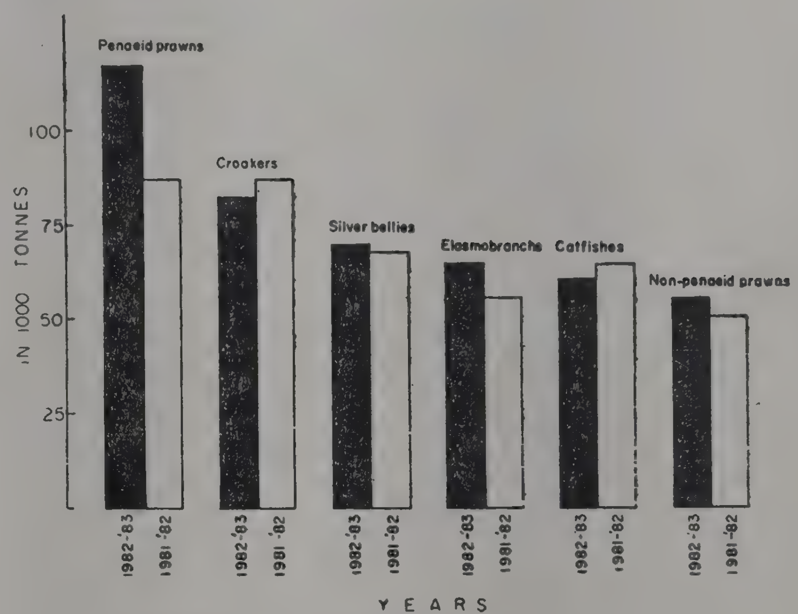

Fig. 2. Comparison of landings of major demersal groups between 1981–82 and 1982–83,

Silver bellies

An increase of about 2,100 t in the catch of silver bellies was observed during 1982–83 as compared to 1981–82, the yield for the two years being about 70,100 and 68,000 t respectively. While there was an increase in the catch in Kerala (6,000 t) and in Andamans (600 t) there was a decrease in the landings in Tamil Nadu 7,000 t) and Andhra Pradesh (500 t).

Elasmobranchs

The landings of elasmobranchs showed an increase of about 9,400 t (17%) during 1982–83 in comparison to 1981–82, the yield for the two years being about 65,100 and 55,700 t respectively. This was due to an increase in the catch in the states of Andhra Pradesh (3,600 t), Tamil Nadu (2,300 t) and Gujarat (1,000 t). In Orissa, however, the yield showed a decrease of about 1,700 t.

Cat fishes

A fall of about 4,100 t (6%) in the yield of cat fishes was noticed during 1982–'83 as compared to 1981–82, the respective catch figures being about 60,800 and 64,900 t. A substantial reduction in the catch was noticed in the states of West Bengal (6,200 t) and Orissa (1,900 t). However, Karnataka (1,600 t), Gujarat (800 t), Kerala (600 t), Goa (600 t) and Maharashtra (500 t) showed an increase in the yield.

Non-penaeid prawns

An increase of about 5,100 t in the landings of non-penaeid prawns was noticed during 1982–83 in comparison to 1981–82. This was due to enhanced landings in the states of Andhra Pradesh (3,300 t), Maharashtra (1,800 t) and Gujarat (550 t).

Perches

A significant increase to the tune of about 14,000 t (40%) was observed in the landings of perches during 1982–83 as compared to 1981–82, the respective figures being about 50,000 and 36,000 t. The states that mainly contributed to this increase were Tamil Nadu (5,500 t), Maharashtra (4,100 t), Andhra Pradesh (2,200 t), Karnataka (1,800 t), Kerala (1,600 t) and Orissa (1,300 t). However, a decline of the order of 3,400 t was observed in Gujarat.

Pomfrets

There was an over all decline of about 3,600 t in the landings of pomfrets during the period under review when compared to that of 1981–82, the respective figures being 48,900 and 52,500 t. While in the states of Gujarat and Maharashtra a decline in the landings of the order of 9,300 and 2,300 t respectively was observed, an increase in the catch to the extent of about 3,000 t each was noted in the states of Kerala and Karnataka.

All India mechanised and non-mechanised fish landings during 1982-83

Out of total landings of 14.15 lakh t, the contribution from mechanised fishing, comprising trawl net and purse seine was 41%. The same from mechanised propulsion, comprising dol net, drift/gillnet, hooks & lines and others was 22%, the contribution from indigenous sector being 37%.

The oil sardine landings during the year 1982–83 was to the tune of 2.02 lakh t of which 58% came from mechanised sector and the rest from non-mechanised sector. In the case of penaeid and non-penaeid prawns landings their shares in the mechanised sector were still higher, the respective percentages being 87 and 80. As much as 71% of the Bombay duck landings came from mechanised sector.

Statewise mechanised and non-mechanised fish landings during 1982-83

Tables 6 (a–e) show the statewise total mechanised and non-mechanised landings and those of important species viz, oil sardine, mackerel, Bombay duck, scia-

Table 6. *Estimated marine fish landings in India from mechanised and non-mechanised sectors during* 1982–83 *(in tonnes)*

	Mechanised								
	Mechanised fishing*		Power propulsion**				Total	Total (non-mechanised)	Grand total
Name of fish	Trawl net	Purse seine	Drift/gill net	Dol net	Hooks & lines	Others			
Oil sardine	1,751	41,315	2	—	—	73,379	1,16,447	85,178	2,01,625
Mackerel	670	6,301	202	—	—	1,985	9,158	15,811	24,969
Bombay duck	1,326	—	17	62,158	—	328	63,829	26,593	90,422
Croakers	60,658	282	3,160	2,193	78	444	66,815	15,355	82,170
Perches	32,404	234	409	38	291	70	33,446	16,580	50,026
Pomfrets	4,493	1,427	18,686	7,258	—	1,360	33,224	15,657	48,881
Tunnies	1,381	971	3,890	—	6	174	6,422	12,993	19,415
Penaeid prawns	95,459	1,033	229	4,501	—	626	1,01,848	15,619	1,17,467
Non-penaeid prawns	4,417	—	13	40,165	—	214	44,809	11,285	56,094
Others	2,93,487	30,395	51,871	19,608	1,027	17,979	4,14,367	3,09,783	7,24,150
TOTAL	4,96,046	81,958	78,479	1,35,921	1,402	96,559	8,90,365	5,24,854	14,15,219
No. of operations of units	16,60,463	71,048	2,84,942	2,63,983	5,681	2,27,077		1,09,04,274	

* Mechanisation used both in fishing operation and in propulsion
** Mechanisation used only for propulsion

Table 6 (a). *Statewise landings of marine fish by mechanised and non-mechanised fishing crafts in West Bengal & Orissa during* 1982–83
(In tonnes)

Name of fish	WEST BENGAL					ORISSA				
	Mechanised Power propulsion					Mechanised Power propulsion				
	Drift/ gill net	Others	Total	Non-mechanised	Grand Total	Mechanised fishing Trawl net	Drift/ gill net	Total	Non-mechanised	Grand Total
Oil sardine	—	—	—	—	—	—	—	—	—	—
Mackerel	—	—	—	2	2	2	—	2	972	974
Bombay duck	10	328	338	1,162	1,500	10	—	10	169	179
Croakers	46	364	410	775	1,185	2,663	21	2,684	1,319	4,003
Perches	—	—	—	51	51	—	—	—	1,662	1,662
Pomfrets	1,460	1,324	2,784	1,882	4,666	162	155	317	2,362	2,679
Tunnies	—	—	—	—	—	—	—	—	305	305
Penaeid prawns	—	20	20	268	288	1,606	—	1,606	425	2,031
Non-penaeid prawns	—	214	214	468	682	225	—	225	1	226
Others	2,122	5,467	7,589	6,481	14,070	6,752	253	7,005	14,426	21,431
TOTAL	3,638	7,717	11,355	11,089	22,444	11,420	429	11,849	21,641	33,490
No. of operations of units	25,837	15,288	41,125	1,48,419		70,234	11,947	82,181	7,86,391	

enids, perches, pomfrets, tunnies, penaeid and non-penaeid prawns and others during the financial year 1982–83. The salient features of fishing by mechanised units including power propulsion and non-mechanised boats in different maritime states of India are described below:

West Bengal

The landings from mechanised boats during 1982–'83 were 11,325 t constituting about 51% of the total landings in the state. (Table 6 (a)). Pomfrets formed the major catch with 25% of the total mechanised catch. In non-mechanised crafts, pomfrets, Bombay duck and sciaenids formed the major catches their individual share of the total non-mechanised catch being 17, 10, and 7 percent respectively.

Orissa

Thirtyfive per cent of the total landings in Orissa came from mechanised fishing crafts during 1982–83 (Table 6 (a)). The species that landed in substantial quantities from mechanised crafts were sciaenids and penaeid prawns forming about 23 and 14 per cent respectively. In non-mechanised crafts, the landings of pomfrets, perches and sciaenids were in sizable quantities their share in the total catch being 10, 8 and 6 per cent respectively.

Andhra Pradesh

About 27% of the total catch in Andhra Pradesh came from mechanised boats almost the entire catch being from trawlers (Table 6 (b)). Penaeid prawns, perches, sciaenids and non-penaeid prawns were landed in good quantities from trawlers, their share being 16, 13, 13 and 3% respectively of the total trawler catch. From non-mechanised crafts, sciaenids formed the major catch accounting for about 5% of the total catch, the other important species being mackerel (4%), non-penaeid prawns (4%), pomfrets (4%), perches (3%) and penaeid prawns (3%).

Tamil Nadu

In Tamil Nadu, mechanised boats landings during 1982–83 constituted about 51% of the total marine fish landings in the state (Table 6(b)). Trawlers contributed about 96% of the total landings from mechanised boats, the balance being from drift/gillnetters and hooks and lines. Sciaenids, penaeid prawns and perches formed the major catches from the mechanised boats, their individual share being 12, 9 and 4 per cent respectively of the total catch. In non-mechanised crafts perches, mackerel and sciaenids, were caught in substantial quantities, contributing about 7, 3 and 2 per cent respectively of the total catch from non-mechanised fishing crafts.

Pondicherry

The landings from mechanised boats in Pondicherry during 1982–83 formed about 35% of the total landings in the state. (Table 6 (b)). The share of trawler catch was about 88% of the total catch from mechanised

Table 6 (b). *Statewise landings of marine fish from mechanised and non-mechanised fishing crafts in Andhra Pradesh, Tamil Nadu and Pondicherry during* 1982–83 *(in tonnes)*

ANDHRA PRADESH

Name of fish	Mechanised – Mechanised fishing – Purse seine	Mechanised – Mechanised fishing – Trawl net	Mechanised – Total	Non-mechanised	Grand Total
Oil sardine	—	—	—	—	—
Mackerel	—	205	205	3,977	4,182
Bombay duck	—	581	581	882	1,463
Croakers	—	4,311	4,311	4,319	8,630
Perches	—	4,442	4,442	3,187	7,629
Pomfrets	—	184	184	3,604	3,788
Tunnies	—	—	..	941	941
Penaeid prawns	—	5,598	5,598	3,108	8,706
Non-penaeid prawns	—	1,202	1,202	3,669	4,871
Others	6	17,784	17,790	68,004	85,794
TOTAL	6	34,307	34,313	91,691	1,26,004
No. of operations of units		1,10,879		2,599,163	

TAMIL NADU

Name of fish	Mechanised – Mechanised fishing – Trawl net	Mechanised – Power propulsion – Drift/gill net	Mechanised – Power propulsion – Hooks & lines	Mechanised – Total	Non-mechanised	Grand Total
Oil sardine	—	—	—	·	1,094	1,094
Mackerel	59	39	—	98	3,646	3,744
Bombay duck	—	—	—	—	8	8
Croakers	14,028	—	—	14,028	2,594	16,622
Perches	5,060	22	284	5,366	8,322	13,688
Pomfrets	297	15	—	312	862	1,174
Tunnies	1	1,583	6	1,590	1,883	3,473
Penaeid prawns	11,415	—	—	11,415	1,634	13,049
Non-penaeid prawns	151	—	—	151	259	410
Others	84,273	2,504	541	87,318	95,373	1,82,691
TOTAL	1,15,284	4,163	831	1,20,278	1,15,675	2,35,953
No. of operations of units	4,97,137	18,058	3,150		38,78,326	

PONDICHERRY

Name of fish	Mechanised – Mechanised fishing – Trawl net	Mechanised – Power propulsion – Drift/gill net	Mechanised – Power propulsion – Hooks & lines	Mechanised – Total	Non-mechanised	Grand Total
Oil sardine	—	—	—	—	—	—
Mackerel	5	—	—	5	733	738
Bombay duck	—	—	—	—	2	2
Croakers	407	—	—	407	152	559
Perches	1,227	1	—	1,228	260	1,488
Pomfrets	—	—	—	—	114	114
Tunnies	—	54	—	54	—	54
Penaeid prawns	230	—	—	230	35	265
Non-penaeid prawns	—	—	—	—	9	9
Others	2,158	487	3	2,648	7,108	9,756
TOTAL	4,027	542	3	4,572	8,413	12,985
No. of operations of units	33,285	2,636	120		2,60,833	

Table 6 (c). *Statewise landings of marine fish from mechanised and non-mechanised fishing crafts in Kerala and Karnataka during* 1982–83 *(in tonnes)*

KERALA

Name of fish	Mechanised – Mechanised fishing – Trawl net	Mechanised – Mechanised fishing – Purse seine	Mechanised – Power propulsion – Drift/Gill net	Mechanised – Power propulsion – Others	Mechanised – Total	Non-mechanised	Grand Total
Oil sardine	1,200	6,401	2	73,379	80,982	78,506	1,59,488
Mackerel	10	1,949	154	1,982	4,095	5,175	9,270
Bombay duck	—	—	—	—	—	—	—
Croakers	2,550	2	32	80	2,664	1,187	3,851
Perches	9,151	6	26	70	9,253	1,527	10,780
Pomfrets	134	206	1,165	34	1,539	2,842	4,381
Tunnies	1	43	1,327	174	1,545	4,760	6,305
Penaeid prawns	26,507	290	—	606	27,403	4,885	32,288
Non-penaeid prawns	—	—	—	—	—	33	33
Others	31,960	661	7,867	11,267	51,755	70,292	1,22,047
TOTAL	71,513	9,558	10,573	87,592	1,79,236	1,69,207	3,48,443
No. of operations of units	3,63,556	8,123	76,779	2,08,497		22,79,293	

KARNATAKA

Name of fish	Mechanised – Mechanised fishing – Purse seine	Mechanised – Mechanised fishing – Trawl net	Mechanised – Power propulsion – Drift/Gill net	Mechanised – Power propulsion – Others	Mechanised – Total	Non-mechanised	Grand Total
Oil sardine	33,274	464	—	—	33,738	1,763	35,501
Mackerel	4,300	325	5	—	4,630	674	5,304
Bombay duck	—	—	—	—	—	—	—
Croakers	239	1,257	1	—	1,497	1,279	2,776
Perches	130	1,952	—	—	2,082	85	2,167
Pomfrets	1,216	601	347	2	2,166	1,044	3,210
Tunnies	928	—	273	—	1,201	1,042	2,243
Penaeid prawns	736	6,676	—	—	7,412	320	7,732
Non-penaeid prawns	—	—	—	—	—	—	—
Others	25,634	28,598	1,297	1,173	56,702	12,333	69,035
TOTAL	66,457	39,873	1,923	1,175	1,09,428	18,540	1,27,968
No. of operations of units	55,326	2,01,104	8,746	3,202		2,41,544	

crafts. The landings of perches were the maximum accounting to about 30% of the total trawler catch.

Kerala

Mechanised boats of all categories, viz fully mechanised and power propelled recorded a catch of about 179,000 tonnes accounting for about 51% of the total marine fish catch in the state during 1982–83. (Table 6 (c)). While fully mechanised boats viz. trawlers and purse-seiners landed about 81,000 tonnes (45%), the balance came from power propelled boats viz drift/gill-netters and others. Oil sardine formed the major catch (81,000 t) from mechanised boats of all categories, its share being about 45% of the total catch from them. Penaeid prawns also were caught in good quantities (27,400 t- 15%) from the different types of mechanised boats.

In non-mechanised boats also oil sardine accounted for a maximum catch of about 79,000 t constituting about 46% of the total catch from them.

Karnataka

About 86% of the total marine fish catch in the state came from mechanised boats. (Table 6 (c)). Purse-seiners landed about 66,000 t forming about 61% of the total catch from mechanised units, the balance came from trawlers (36%), gillnetters (2%) and others (1%). Oil Sardine constituted the major catch (31%) from mechanised fishing crafts, the other important species being penaeid prawns (7%), mackerel (4%), pomfrets (2%) and perches (2%).

Oil sardine (10%), sciaenids (7%), pomfrets (6%) and tunnies (6%) were the important fishes from non-mechanised boats.

Goa

Out of total catch of about 36,000 t in Goa, mechanised boats contributed about 29,000 t forming about 81%, the bulk of the catch being from trawlers and purse-seiners (Table 6 (d)). While the trawlers accounted for about 77% of the total catch from mechanised units, purse-seiners landed about 20% and gillnetters and others about 3%. The important fin and shell fishes from mechanised boats were penaeid prawns, sciaenids, oil sardine and perches whose share being 20, 8, 6 and 5% respectively of the total catch from mechanised crafts. (Ref. page 6)

Oil sardine formed the major catch constituting about 3,600 t (54%) of the total catch from non-mechanised boats.

Maharashtra

In Maharashtra, the landings from mechanised boats were about 242,000 t accounting for 90% of the total landings in the state. (Table 6 (d)). Among the mechanised boats, the share of dol netters, trawlers and gillnetters was 48, 46 and 6% respectively of the total catch from mechanised boats. Bombay duck formed the major catch (47,600 t-20%) from mechanised fishing crafts. The other important species that landed from mechanised boats were non-penaeid prawns (40,000 t-17%), penaeid prawns (33,200 t-14%), croakers (14,500 t-6%) and pomfrets (14,000 t-6%). (Ref. page 6)

Table 6 (e). *Landings of marine fish from mechanised and non-mechanised fishing crafts in Gujarat during* 1982–83 *(in tonnes)*

	GUJARAT						
	Mechanised						
	Mechanised fishing		Power propulsion				
Name of fish	Trawl net	Dol net	Drift/ gillnet	Hooks & lines	Total	Non-Mechanised	Grand total
Bombay duck	464	14,792	—	—	15,256	23,040	38,296
Perches	1,992	—	343	—	2,335	419	2,754
Croakers	21,152	527	2,374	—	24,053	935	24,988
Pomfrets	1,269	131	10,357	—	11,757	1,036	12,793
Tunnies	22	—	264	—	286	4	290
Penaeid prawns	8,763	226	85	—	9,074	3,242	12,316
Non-penaeid prawns	2,360	681	13	—	3,054	2,010	5,064
Others	50,645	2,329	29,259	30	82,263	17,673	99,936
TOTAL	86,667	18,686	42,695	30	1,48,078	48,359	1,96,437
No. of operations of units	1,23,977	43,699	60,433	210		2,34,494	

Non-penaeid prawns (4,800 t-19%), croakers (2,500 t-10%), pomfrets (1,700 t-7%), penaeid prawns (1,600 t-6%), tunnies (1,400 t-5%) and Bombay duck (1,300 t-5%) were the important species caught in non-mechanised units.

Gujarat

The landings from mechanised fishing crafts in Gujarat during 1982–83 were about 148,000 t constituting about 75% of the total marine fish landings in the state. (Table 6 (e)). Trawlers, gillnetters and dol netters contributed to 59, 29 and 12% respectively of the total landings from mechanised units. Sciaenids (24,000 t-16%), Bombay duck (15,300 t-10%), pomfrets (11,800 t-8%) and penaeid prawns (9,100 t-6%) were the important species from the mechanised boats.

In non-mechanised boats, Bombay duck (23,000 t-48%) formed the major catch.

Landings of mechanised boats at important centres.

Visakhapatnam outer harbour

The total landings from trawlers during 1982–83 showed a decline of about 700 t (12%) as compared to 1981–82. (Table 7 (a)). The number of operations also likewise declined by about 900. The catch per unit effort (per operation) during 1982–83 and 1981–82 was 197 and 216 kg respectively. The decline in the total catch was mainly due to reduced landings of ribbon fishes, perches, croakers, crabs and carangids to the extent of about 530, 300, 190, 190 and 170 t respectively. The landings of lizard fishes, however, showed an increasc of about 510 t.

Kakinada fisheries harbour

Both the catch and the number of operations of trawlers showed an increase during 1982–83 as compared to 1981–82 (Table 7 (a)). While the catch increased by about 4,300 t (36%), the number of operations increased by about 3,900. The catch per unit effort also increased to 384 kg from 311 kg recorded in 1981–82. The landings of non-penaeid prawns, penaeid prawns, anchovies, silver bellies, threadfin breams, Bombay duck and ribbon fishes showed an increase of about 650, 600, 510, 460, 460, 320 and 310 t respectively. Other sardines, however, accounted for lower landings by about 450 t.

Pudumanaikuppam, Tamilnadu

The total catch from trawlers and gill netters showed an increase of about 2,100 t (30%) during 1982–83 as compared to 1981–82 (Table 7 (a)). While the landings fiom trawlers constituted about 98% of the total mechanised landings, gillnetters accounted for the rest. The catch per unit effort for trawlers was 263 kg and the same was 115 kg for gillnetter. While the total landings of cephalopods, threadfin breams, lizard fishes, carangids, ribbon fishes and penaeid prawns increased by about 390, 380, 160, 160, 150 and 120 t. silver bellies, croakers and elasmobranchs recorded a reduction in the landings by about 350, 240 and 220 t respectively.

Cuddalore fisheries harbour

An increase of about 2,800 t in the total catch from trawlers and gillnetters was noticed during 1982–83 in comparison to 1981–82. (Table 7 (a)). The trawlers landed about 57% of the total mechanised catch with 253 kg as the catch per unit effort, the corresponding figures for gillnetters being 43% and 412 kg. The landings from trawlers and gill netters showed an overall increase due to enhanced landings of seer fishes, silver bellies, elasmobranchs, tunnies, threadfin breams, crabs and penaeid prawns by about 660, 490, 410, 360, 220, 170 and 120 t respectively.

Nagapattinam

The landings of trawlers during 1982–83 increased by about 2,100 t (44%) as also the number of operations by about 2,900 (Table 7 (b)). The catch per unit effort likewise increased to 323 kg from 259 kg recorded in 1981–82. The fishes that mainly contributed to the higher catches were croakers, other clupeoids, threadfin breams, silver bellies and penaeid prawns whose landings increased by about 290, 260, 240, 230 and 150 t respectively.

Mandapam

Trawlers recorded an increase of about 1,700 t (35%) in their catch during 1982–83 as compared to 1981–82. (Table 7 (b)). There was also an increase in the number of operations by about 2,500. The catch per unit effort also increased to 140 kg from 110 kg recorded in 1981–82. The increase in the total catch of trawlers was mainly brought about by the significantly higher landings of silver bellies, the increase being about 1,000 t.

Rameswaram

The total catch from trawlers and gillnetters increased only marginally to about 22,800 t in 1982–83 from about 22,600 t recorded in 1981–82, almost the entire catch

Table 7 (a). *Composition of marine fish landings (in tonnes) from mechanised boats at major fish landing centres in the east coast of India*

Sl.No.	Name of fish	Visakhapatnam outer harbour		Kakinada fisheries harbour		Pudumanikuppam				Cuddalore fisheries harbour			
		1982–83 Trawl net	1981–82 Trawl net	1982–83 Trawl net	1981–82 Trawl net	1982–83 Trawl net	1982–83 Gill net	1982–83 Total	1981–82 Total	1982–83 Trawl net	1982–83 Gill net	1982–83 Total	1981–82 Total
1.	Elasmobranchs												
	a. Sharks	15	7	38	52	31	26	57	156	—	482	482	96
	b. Skates	35	37	80	34	12	—	12	25	3	4	7	
	c. Rays	79	65	192	296	94	10	104	216	—	24	24	11
2.	Eels	31	16	196	95	14	1	15	23	—	—	—	—
3.	Cat fishes	186	157	245	250	5	3	8	8	—	—	—	—
4.	Clupeoids												
	a. Wolf herring (*Chirocentrus*)	6	5	1	—	2	—	2	2	—	—	—	—
	b. Oil sardine	—	—	—	—	—	—	—	—	—	—	—	—
	c. Other sardines	2	10	95	543	3	—	3	—	—	—	—	—
	d. Hilsa shad (*Hilsa ilisha*)	—	—	—	—	—	—	—	—	—	—	—	—
	e. Other shads (Other *Hilsa*)	—	—	1	—	—	—	—	—	—	—	—	—
	f. Anchovies												
	Coilia	—	—	7	—	—	—	—	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—	—	—	—	—
	Stolephorus (*Anchoviella*)	189	133	514	187	13	—	13	82	22	—	22	40
	Thrissina	—	—	—	—	—	—	—	—	—	—	—	—
	Thryssa (*Thrissocles*)	60	68	261	89	23	—	23	40	—	—	—	8
	g. Other clupeoids	8	39	386	263	15	5	20	3	—	37	37	26
5.	Bombay duck (*Harpadon nehereus*)	8		357	34	—	—	—	—	—	—	—	—
6.	Lizard fishes (*Saurida & Saurus*)	966	456	238	195	729	—	729	566	225	—	225	140
7.	Half beaks & full beaks (*Hemirhamphus & Belone*)	—	—	—	—	—	—	—	46	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—	—	—
9.	Perches												
	a. Rock cods	2	4	—	—	—	—	—	—	—	6	6	—
	b. Snappers	1	1	7	3	—	—	—	—	—	—	—	—
	c. Pig-face breams	—	—	—	—	7	—	7	4	—	—	—	—
	d. Threadfin breams	532	783	1,087	626	1,524	—	1,524	1,148	328	—	328	106
	e. Other perches	457	503	1,643	1,437	728	—	728	404	57	—	57	30
10.	Goatfishes (Red mullets)	216	104	205	48	91	—	91	35	40	—	40	28
11.	Threadfins (Polynemids)	28	35	24	18	3	—	3	5	—	—	—	—
12.	Croakers (Sciaenids)	349	534	583	583	224	—	224	461	142	—	142	70
13.	Ribbon fishes	297	825	861	552	303	—	303	152	—	—	—	—
14.	Carangids												
	a. Horse mackerel	—	—	—	—	—	—	—	—	—	—	—	—
	b. Scads	68	268	2,696	2,546	203	—	203	13	—	—	—	—
	c. Leather-jackets (*Chorinemus*)	—	—	—	—	—	1	1	3	—	9	9	11
	d. Other carangids	106	79	109	48	26	1	27	56		20	20	17
15.	Silver bellies (*Leiognathus & Gazza*)	368	348	947	485	1,336	—	1,336	1,690	826	—	826	334
16.	Big-jawed jumper (*Lactarius*)	14	55	43	17	1	—	1	1	—	—	—	—
17.	Pomfrets												
	a. Black pomfret	8	7	11	1	4	1	5	3	—	—	—	—
	b. Silver pomfret	5	9	8	15	—	—	—	1	—	—	—	—
	c. Chinese pomfret	—	—	—	—	—	—	—	—	—	—	—	1
18.	Mackerels												
	a. Indian mackerel	13	28	112	291	8	—	8	7	—	—	—	—
	b. Other mackerels	—	—	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes												
	a. *S. commerson*	—	—	—	—	2	38	40	75	—	701	701	44
	b. *S. guttatus*	2	1	—	—	1	18	19	30	—	—	—	—
	c. *S. lineolatus*	—	—	—	—	—	12	12	12	—	—	—	—
	d. *Acanthocybium* Sp.	—	—	—	—	—	—	—	—	—	—	—	—

Contd.

20.	Tunnies												
	a. *E. affinis*	—	—	—	—	1	8	9	19	—	408	408	51
	b. *Auxis* spp.	—	—	—	—	—	1	1	15	—	—	—	—
	c. *K. pelamis*	—	—	—	—	—	—	—	—	—	—	—	—
	d. *T. tongol*	—	—	—	—	—	—	—	2	—	—	—	—
	e. Other tunnies	—	—	—	—	—	26	26	39	—	64	64	7
21.	Bill fishes	—	—	—	—	—							
22.	Barracudas *(Sphyraena)*	14	18	74	44	65	—	65	11	—	23	23	23
23.	Mullets *(Mugil)*	—	—	—	—	—	—	—	—	—	—	—	—
24.	Unicorn Cod *(Bregmaceros)*	—	—	—	—	—	—	—	—	—	—	—	—
25.	Flatfishes												
	a. Halibut *(Psettodes erumei)*	12	7	2	—	4	—	4	—	—	—	—	—
	b. Flounders	—	—	13		4	—	4	—	—	—	—	—
	c. Soles	47	71	247	80	32	—	32	58	20	—	20	13
26.	Crustaceans												
	a. Penaeid prawns	673	663	2,671	2,067	1,181	—	1,181	1,062	234	—	234	114
	b. Non penaeid prawns	5	1	1,029	381	—	—	—	—	—	—	—	—
	c. Lobsters	3	—	—	—	30	—	30	5	—	—	—	—
	d. Crabs	133	321	417	150	232	—	232	195	197	—	197	28
	e. Stomatopods	9	10	375	184	28	—	28	31	—	—	—	—
27.	Cephalopods	229	201	114	82	535	—	535	143	54	—	54	33
28.	Miscellaneous	44	42	321	215	1,577	2	1,579	272	188	3	191	92
	TOTAL	5,220	5,911	16,210	11,911	9,091	153	9,244	7,119	2,336	1,781	4,117	1,323
	No. of operations of fishing units	26,492	27,402	42,228	38,300	34,567	1,331			9,232	4,327		

Table 7 (b). *Composition of marine fish landings from mechanised boats at major fish landing centres along the east cost of India (Fig. in tonnes)*

		Nagapattinam		Mandapam		Rameswaram				Tuticorin fisheries harbour			
		1982–83	1981–82	1982–83	1981–82	1982–83			1981–82	1982–83			1981–82
Sl.No.	Name of fish	Trawl net	Trawl net	Trawl net	Trawl net	Trawl net	Gill net	Total	Total	Trawl net	Gill net	Total	Total
1.	Elasmobranchs												
	a. Sharks	4	25		1				8	381		381	472
	b. Skates	26											
	c. Rays	295	198	236	243	2,330		2,330	3,319	512		512	548
2.	Eels	37	26		3								2
3.	Catfishes	175	98	48	124	202		202	200	40		40	71
4.	Clupeoids												
	a. Wolf herring *(Chirocentrus)*		19	2			1	1	16	100	1	101	121
	b. Oil sardine		2						4				
	c. Other sardines			31	26	52		52		15	1	16	94
	d. Hilsa shad *(Hilsa ilisha)*			6		5		5	100				
	e. Other shads (Other *Hilsa*)			5	8	6		6	56	7		7	
	f. Anchovies												
	Coilia	191	245										
	Setipinna		10			9		9					1
	Stolephorus (Anchoviella)	293	195							89		89	180
	Thrissina		7		8								
	Thryssa	225	154	27	24								150
	(Thrissocles)					15		15		1,597		1,597	1,935
	g. Other clupeids	545	288	117	77	351		351	328	820		820	370
5.	Bombay duck *(Harpadon nehereus)*												
6.	Lizard fishes *(Saurida & Saurus)*	196	155	10	7	156		156	185	50		50	136
7.	Half Beaks & Full Beaks *Hemirhamphus & Belone*												
8.	Flying fishes												
9.	Perches												
	a. Rock cods	1											
	b. Snappers				9	2		2		145	1	146	58
										11		11	36

Contd.

c. Pig-face breams			20	5					9		9	36
d. Threadfin breams	525	290	2	2					446		446	103
e. Other perches	280	155	94	84	101		101	53	13		13	30
10. Goatfishes (Red mullets)	32	9	73	48	344		344	468	7		7	7
11. Threadfins (Polynemids)				1					1		1	
12. Croakers (Sciaenids)	866	581	319	269	2,754		2,754	2,596	753		753	881
13. Ribbon fishes	235	115	7	16	3		3	1	35		35	97
14. Carangids												
a. Horse Mackerel												
b. Scads												
c. Leather-jackets *(Chorinemus)*			1	6					5		5	
d. Other carangids	233	149	40	30	103		103	43	104		104	86
15. Silver bellies *(Leiognathus & Gazza)*	967	733	3,659	2,626	12,373		12,373	11,162	2,144		2,144	1,607
16. Big-jawed jumper *(Lactarius)*	46	33	1	1					61	2	63	64
17. Pomfrets		1										
a. Black pomfret	1	5	3	1								
b. Silver pomfret	37	27	13	20	85		85	261	2		2	15
c. Chinese pomfret								1				
18. Mackerels												
a. Indian mackerel	2							4		2	2	5
b. Other mackerels												
19. Seer fishes								3	1	2	3	9
a. *S. commerson*								2				21
b. *S. guttatus*												
c. *S. lineolatus*												
d. *Acanthocybium* Sp.												
20. Tunnies												
a. *E. affinis*												2
b. *Auxis* spp.												
c. *K. pelamis*												
d. *T. tonggol*												
e. Other tunnies												
21. Bill fishes												
22. Barracudas *(Sphyraena)*	95	26							61	1	62	45
23. Mullets *(Mugil)*	2	5										2
24. Unicorn cod *(Bregmaceros)*												
25. Flatfishes												
a. Halibut	99	62			15		15	1				
b. Flounders												
c. Soles	193	123	42	58	160		160	186	44		44	124
26. Crustaceans												
a. Penaeid prawns	748	600	681	729	1,905		1,905	2,092	730		730	3,692
b. Non-penaeid prawns	65	84										
c. Lobsters	20	5			1		1		11		11	
d. Crabs	202	144	198	205	696		696	679	16		16	47
e. Stomatopods	16	16	9	23				13	12		12	
27. Cephalopods	77	29	79	30	202		202	170	10		10	5
28. Miscellaneous	253	225	640	16	943		943	628	1,209	1	1,210	3,492
TOTAL	6,982	4,839	6,363	4,700	22,813	1	22,814	22,579	9,441	11	9,452	14,544
No. of operations of fishing units	21,614	18,698	45,392	42,903	94,627	4		1,07,211	24,702	62		

Table 7(c). *Composition of marine fish landings from mechanised boats at major fish landing centres along the west coast of India (Fig in tonnes)*

Sl.No.	Name of fish	Sakthikulangara 1982–83 Trawl net	Sakthikulangara 1982–83 Gill net	Sakthikulangara 1982–83 Total	Sakthikulangara 1981–82 Total	Cochin fisheries harbour 1982–83 Trawl net	Cochin 1982–83 D.Gill net	Cochin 1982–83 Purse seine	Cochin 1982–83 Hooks & lines	Cochin 1982–83 Total	Cochin 1981–82 Total
1.	Elasmobranchs										
	a. Sharks	13	602	615	367	9	454	—	—	463	412
	b. Skates	1	8	9	24	1	2	—	—	3	10
	c. Rays	451	16	467	335	47	39	—	—	86	89
2.	Eels	11	—	11	2	—	3	—	—	3	1
3.	Cat fishes	2,588	270	2,858	3,624	280	361	87	1	729	654
4.	Clupeoids										
	a. Wolf herring *(Chirocentrus)*	—	—	—	2	4	1	—	—	5	3
	b. Oil sardine	762	2	764	30	262	—	6,285	—	6,547	14,358
	c. Other sardines	—	—	—	—	—	—	152	—	152	409
	d. Hilsa shad *(Hilsa ilisha)*	—	—	—	—	1	—	—	—	1	—
	e. Other shads *(Other Hilsa)*										
	f. Anchovies										
	Coilia										
	Setipinna										
	Stolephorus (Anchoviella)	680	—	680	501	248	—	260	[illegible]	508	171
	Thrissina										
	Thryssa (Thrissocles)	—	—	—	—	22	—	—	—	22	42
	g. Other clupeoids	—	—	—	—	4	—	31	—	35	24
5.	Bombay duck *(Harpadon nehereus)*										
6.	Lizard fishes *(Saurida & Saurus)*	4,732	—	4,732	4,890	343	—	—	—	343	332
7.	Half beaks & full beaks *(Hemihamphus & Belone)*	—	3	3	2	—	—	—	—	—	3
8.	Flying fishes	—	—	—	—	—	4	—	—	4	—
9.	Perches										
	a. Rock cods	—	—	—	70	—	9	—	10	19	38
	b. Snappers	1	2	3	2	—	—	—	4	4	40
	c. Pig-face breams										
	d. Threadfin breams	4,832	—	4,832	3,701	3,268	—	—	—	3,268	2,602
	e. Other perches	369	—	369	460	157	4	6	—	167	216
10.	Goatfishes (Red mullets)	—	—	—	3	2	—	—	—	2	—
11.	Threadfins (Polynemids)	—	—	—	—	—	4	3	—	7	—
12.	Croakers (Sciaenids)	1,325	8	1,333	1,243	394	—	2	—	396	232
13.	Ribbon fishes	54	23	77	38	77	1	2	—	80	16
14.	Carangids										
	a. Horse Mackerel	—	—	—	3	—	—	—	—	—	22
	b. Scads	22	3	25	73	—	—	1	—	1	2
	c. Leather-jackets *(Chorinemus)*	—	19	19	2	—	93	10	—	103	21
	d. Other carangids	16	69	85	71	54	86	79	—	219	497
15.	Silver bellies *(Leiognathus & Gazza)*	702	—	702	500	72	—	4	—	76	41
16.	Big-jawed jumper *(Lactarius)*	28	—	28	124	46	—	—	—	46	26
17.	Pomfrets										
	a. Black pomfret	—	64	64	24	—	98	204	—	302	156
	b. Silver pomfret	—	3	3	2	14	18	—	—	32	13
	c. Chinese pomfret	—	—	—	—	1	7	—	—	8	9
18.	Mackerels										
	a. Indian mackerel	6	70	76	25	2	46	1,901	—	1,949	1,889
	b. Other mackerels										
19.	Seer fishes										
	a. *S. commerson*	—	38	38	23	—	280	—	—	280	227
	b. *S. guttatus*	—	167	167	66		46	1	—	47	13
	c. *S. lineolatus*										
	d. *Acanthocybium* Sp.										
20.	Tunnies										
	a. *E. affinis*	—	329	329	250	—	401	43	—	444	613
	b. *Auxis* spp.	—	1	1	20	—	294	—	—	294	416
	c. *K. pelamis*	—	—	—	—	—	—	—	—	—	1
	d. *T. tonggol*	—	—	—	—	—	7	—	—	7	19
	e. Other tunnies	—	—	—	17	—	5	—	—	5	116

Contd.

Sl. No.	Name of fish										
21.	Bill fishes	—	17	17	15	—	12	—	—	12	35
22.	Barracudas *(Sphyrnena)*	37	—	37	42	30	9	1	—	40	85
23.	Mullets *(Mugil)*	—	—	—	—	—	—	22	—	22	67
24.	Unicorn cod *(Bregmaceros)*										
25.	Flatfishes										
	a. Halibut *(Psettodes erumei)*	28	—	28	61	—	—	—	—	—	12
	b. Flounders										
	c. Soles	1,978	—	1,978	1,970	339	—	—	—	339	284
26.	Crustaceans										
	a. Penaeid prawns	9,425	—	9,425	9,631	2,957	—	289	—	3,246	2,521
	b. Non penaeid prawns										
	c. Lobsters	11	—	11	3	—	—	—	—	—	—
	d. Crabs	33	—	33	65	73	—	—	—	73	78
	e. Stomatopods	2,068	—	2,068	1,859	326	—	—	—	326	172
27.	Cephalopods	1,289	—	1,289	842	140	—	—	—	140	104
28.	Miscellaneous	2,443	13	2,456	1,880	111	3	—	—	114	185
	TOTAL	33,905	1,727	35,632	32,862	9,284	2,287	9,383	~~16~~ 15	20,969	27,276
	No. of operations of Fishing units	1,28,847	14,321		1,38,279	48,545	19,437	8,123	54		

Table 7 (d): *Composition of marine fish landing from mechanised boats, at major fish landing centres along the west cost of India (Fig. in tonnes)*

Sl. No.	Name of fish	Sassoon docks 1982–83 Trawl net	Dol net	Gill net	Hooks & lines	Total	1981–82 Total	New Ferry Wharf 1982–83 Trawl net	Dol net	Total	1981–82 Total
1.	Elasmobranchs										
	a. Sharks	1,020	3	212	70	1,305	1,166	1,120	—	1,120	543
	b. Skates	306	—	38	—	344	96	1,508	—	1,508	127
	c. Rays	444	—	72	4	520	545	1,854	—	1,854	388
2.	Eels	154	—	35	132	321	204	3,466	—	3,466	2,180
3.	Cat fishes	3,231	7	212	134	3,584	2,605	1,784	2	1,786	826
4.	Clupeoids										
	a. Wolf herring *(chirocentrus)*	322	7	95	—	424	236	505	—	505	93
	b. Oil sardine	87	—	—	—	87	96	—	—	—	27
	c. Other sardines	49	1	—	—	50	5	—	—	—	5
	d. Hilsa shad *(Hilsa ilisha)*	—	—	—	—	—	—	—	—	—	—
	e. Other shads *(Other hilsa)*	151	—	149	—	300	124	—	—	—	1
	f. Anchovies										
	Coilia	757	68	—	—	825	1230	394	2	396	825
	Setipinna										
	Stolephorus (Anchoviella)	—	—	—	—	—	—	—	15	15	—
	Thrissina	—	—	—	—	—	—	—	—	—	—
	Thryssa (Thrissocles)	386	17	1	—	404	85	122	—	122	81
	g. Other clupeoids	236	36	47	—	319	138	570	2	572	159
5.	Bombay duck *(Harpadon nehereus)*	3	220	—	—	223	458	200	5	205	182
6.	Lizard fishes *(Saurida & Saurus)*	616	—	—	—	616	414	279	—	279	87
7.	Half beaks & full beaks *(Hemihamphus & Belone)*	—	—	—	—	—	—	—	—	—	1
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
	a. Rock cods	54	—	—	—	54	41	131	—	131	15
	b. Snappers	—	—	—	—	—	6	5	—	5	50
	c. Pig-face breams	—	—	—	—	—	—	—	—	—	—
	d. Threadfin breams	3,139	1	—	—	3,140	1,623	1,061	—	1,061	424
	e. Other perches	378	—	3	2	383	29	1,006	—	1,006	38
10.	Goatfishes (Red mullets)	744	—	—	—	744	113	644	—	644	171
11.	Threadfins (Polynemids)	335	—	28	7	370	106	45	—	45	157
12.	Croakers (Sciaenids)	2,576	30	167	50	2,823	4,118	4,221	—	4,221	3,480
13.	Ribbon fishes	2,074	71	—	—	2,145	1,667	1,622	—	1,622	1,698
14.	Carangids										
	a. Horse Mackerel	9	—	34	—	43	23	—	—	—	23
	b. Scads	—	—	—	—	—	—	—	—	—	—
	c. Leather-jackets *(Chorinemus)*	9	—	30	—	39	36	129	—	129	88
	d. Other carangids	361	3	7	—	371	63	895	—	895	39

Contd.

15. Silver bellies *(Leiognathus & Gazza)*	9	—	—	—	9	—	—	—	—	2
16. Big-jawed jumper *(Lactarius)*	522	—	2	—	524	34	711	—	711	—
17. Pomfrets										
a. Black pomfret	44	3	244	—	291	249	131	—	131	—
b. Silver pomfret	718	48	215	—	981	284	220	—	220	117
c. Chinese pomfret	1	12	—	—	13	5	—	—	—	—
18. Mackerels										
a. Indian mackerel	13	—	4	—	17	—	51	—	51	—
b. Other mackerels	—	—	—	—	—	186	529	—	529	10
19. Seer fishes										
a. *S, commerson*	130	—	173	—	303	82	—	—	—	—
b. *S. guttatus*	84	—	48	—	132	12	—	—	—	128
c. *S. lineolatus*										
d. *Acanthocybium* sp.										
20. Tunnies										
a. *E, affinis*	—	—	—	—	—	94	—	—	—	—
b. *Auxis* spp.										
c. *K. pelamis*	—	—	—	—	—	7	—	—	—	—
d. *T. tonggol*	—	—	—	—	—	519	—	—	—	—
e. Other tunnies	95	—	314	—	409	—	1,257	—	1,257	419
21. Bill fishes	—	—	113	—	113	113	—	—	—	1
22. Barracudas *(Sphyraena)*	79	—	—	—	79	—	—	—	—	—
23. Mullets *(Mugil)*										
24. Unicorn cod *(Bregmaceros)*	—	—	—	—	—	3	—	—	—	—
25. Flatfishes	—	—	—	—	—	29	—	—	—	—
a. Halibut *(Psettodes erumei)*	122	—	—	—	122	1	477	—	477	9
b. Flounders	—	—	—	—	—	33	—	—	—	32
c. Soles	416	—	—	—	416	376	184	—	184	517
26. Crustaceans										
a. Penaeid prawns	12,829	168	—	—	12,997	6,968	8,886	1	8,887	5,848
b. Non penaeid prawns	185	1,144	—	—	1,329	1,496	9	35	44	494
c. Lobsters	295	1	4	—	300	97	211	—	211	232
d. Crabs	83	—	—	—	83	—	—	—	—	112
e. Stomatopods	—	—	—	—	—	1	164	1	165	—
27. Cephalopods	1,989	2	—	—	1,991	1,278	2,473	—	2,473	685
28. Miscellaneous	634	69	48	6	757	166	674	14	688	355
TOTAL	35,689	1,911	2,295	405	40,300	27,260	37,538	77	37,615	20,669
No. of operations of Fishing units	23,305	13,112	3,502	1,705			22,047	553		

being from trawlers (Table 7 (b)). The catch per unit effort from trawlers was 241 kg. While the catch of silver bellies and croakers increased significantly by about 1,200 and 160 t respectively in trawl catches, the landings of elasmobranchs showed a sharp decline of about 1,000 t. Penaeid prawns, pomfrets and goatfishes also recorded lower landings, the decrease being about 190, 180 and 120 t respectively.

Tuticorin fisheries harbour

A decline in the total catch from trawlers and gillnetters by about 5,100 t (35%) was noticed during 1982–83 as compared to 1981–82 (Table 7 (b)). The number of operations of both the mechanised units also declined by about 8,600. Almost the entire catch came from trawlers, the catch per unit effort from them being 382 kg. A sharp decrease of about 3,000 t in the catch of penaeid prawns from trawlers was seen during 1982–83 in comparison to 1981–82. The landings of anchovies also declined by about 580 tonnes. An increase of about 540, 450 and 340 t respectively in the catches of silver bellies, other clupeoids and threadfin breams was, however, noticed.

Sakthikulangara, Kerala

Both the total catch from trawlers and gillnetters and the number of operations showed an increase of about 2,800 t (8%) and about 4,900 respectively (Table 7 (c)). The catch from trawlers formed about 95% of the total mechanised landings, the catch per unit effort in trawlers and gillnetters being 263 and 121 kg respectively. While the landings of threadfin breams, oil sardines, cephalopods, elasmobranchs, stomatopods and silver bellies from trawlers and gill netters increased by about 1,130, 730, 450, 370, 210 and 200 t respectively, the catch of cat fishes and penaeid prawns showed a decline of about 770 and 210 t respectively.

Cochin fisheries harbour

The combined catch of trawlers, gillnetters, purse-seiners and in hooks and lines during 1982–83 declined to about 21,000 t from about 27,000 t recorded in 1981–82, the reduction being of the order of 6,000 t (Table 7 (c)). The share of various types of gears viz. trawls, gillnets and purse seines was 44%, 11% and 45% respectively of the total catch during 1982–83. The combined total number of operations, however, showed an increase of about 3,600. The catch per unit effort for trawlers, gillnetters, purse-seiners and hooks & lines was 191, 118, 1153 and 296 kg respectively. The reduction in the total landings was mainly due to a fall in the catches of oil sardine to the tune of about 7,800 t., particularly in purse-seines during 1982–83 as compared to 1981–82. The catch of penaeid prawns and threadfin breams, however, showed an increase of about 720 and 670 t respectively.

Sassoon docks, Bombay

During 1982–83, the total catch obtained from trawlers, dol netters, gillnetters and in hooks & lines was about 40,000 tonnes in comparison to 27,000 t recorded during 1981–82, showing an increase of about 13,000 t (48%) (Table 7 (d)). While 88% of the total landings were by trawlers, the remaining were shared by gillnetters (6%), dol netters (5%) and hooks and lines (1%), the catch per unit effort for the four categories of gears being 1531, 146, 655 and 238 kg respectively. The enhanced catch of penaeid prawns (6,000 t), threadfin breams (1,520 t), cat fishes (980 t), cephalopods (710 t), silver pomfrets (700 t), goat fishes (630 t), big jawed jumper (490 t) and ribbon fishes (480 t) contributed to the higher landings in Sassoon docks during 1982–83 as compared to 1981–82. The landings of croakers, however, showed a decline of about 1,300 t.

New ferry wharf, Bombay

During 1982–83, trawlers and dol netters operated, the catch from them being about 37,600 t showing a significant increase of about 16,900 t (82%) as compared to 1981–82 when about 20,700 t were landed. (Table 7(d)). Almost the entire catch during 1982–83 was from trawlers (37,500 t). The number of operations of all the gears put together during the year was 22,600 as compared to 19,800 recorded last year showing an increase of about 2,800. While the catch per unit effort for trawlers was 1,703 kg, the same for dol netters was 139 kg. The higher catch during 1982–83 was due to increased landings of elasmobranchs (3,400 t), penaeid prawns (3,000 t), cephalopods (1,800 t), perches (1,700 t) eels (1,300 t), cat fishes (1,000 t), carangids (900 t), tunnies (800 t) and croakers (700 t). The landings of non-penaeid prawns and anchovies, however, showed a decline of about 500 and 400 t. respectively.

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CONTENTS

Cover photo : Small fishing trawlers at the jetty at Sakthikulangara

MONSOON PRAWN FISHERY OF NEENDAKARA COAST, KERALA—
A CRITICAL STUDY

M. J. George, C. Suseelan, M. M. Thomas, N. S. Kurup, K.N. Rajan, V. S. Kakati, K. N. Gopalakrishnan, K. Chellappan, K. K. Balasubramanian and C. Nalini

Introduction

In a previous article in these columns *(Mar. Fish. Infor. Serv. T & E Ser.* **18**: 1-8, 1980) the results of a detailed analysis of the prawn fishery of Neendakara area with special reference to the trends in production, fishing operations, species composition, seasonal abundance and other biological aspects have been reported. The depletionary tendencies in the fishery leading to an economic overfishing of the resources and the need for adopting suitable conservation measures were indicated in the study. Since the publication of this report in 1980, in a further monitoring of the fishery with a view to evaluate the extent of overfishing of the major species involved during the peak season, the effect of fishing over the seasons on the size of the shrimps and to determine the effective conservation measures to be adopted for optimum exploitation of the resources with reference to both size as well as quantity of the species, an intensive study of the fishery was undertaken during the peak fishing seasons of 1980 to 1982. The outcome of this critical evaluation in continuation of the earlier study is reported in the present contribution.

Trends in seasonal fishery (Fig. 1)

As established earlier the peak fishing season accounting for nearly 83% of the total trawl landings of the year, of which about 38% are constituted by prawns, is during the southwest monsoon period June to September when trawling operations remain very inactive in other parts of the west coast. So the prawn fishery of the area is almost a monsoon fishery, nearly 87% of the total prawn catches of the whole year being landed during the months June to September. Hence the present intensive study is limited to the particular season of the fishery.

The trend in prawn landings at Neendakara-Sakthikulangara area in relation to total catch and effort during the monsoon seasons of the 10 year period from 1973 to 1982 is shown in table 1. The maximum catch during the season (47,951 tonnes) is recorded in 1975. In 1976 there was a steep decline to 11,538 tonnes, and in 1980 again steadily increased to 36,070 tonnes. Thereafter both in 1981 and 1982 very poor catches of less than 8,000 tonnes have been recorded. The effort and catch per effort also show a very similar trend.

Table 1: *Estimated catch, effort and catch rates of prawns for the monsoon period (June-September) against the annual prawn landings at Sakthikulangara (Neendakara) from* 1973 *to* 1982.

Year	Effort (No. of trawler trips)	Total prawn catch (tonnes)	Catch/ boat/ day (kg.)	Annual prawn landings at the centre (tonnes)
1973	62,859	38,542	613	45,477
1974	75,366	18,698	248	27,765
1975	1,50,364	47,951	318	56,750
1976	43,444	11,538	265	14,993
1977	81,184	21,290	262	24,121
1978	1,30,527	28,017	214	33,143
1979	69,455	12,784	178	14,582
1980	99,411	36,070	362	36,558
1981	62,557	7,444	119	9,399
1982	66,708	7,278	109	9,487

Monthly catch variations

From the data given in table 2, over the years it is seen that the fishery starts in the month of June, picks up considerably in July and August and decreases by September, recording the maximum catches either in July or in August. Only in one exceptional year, *ie.* 1977 a regular increase from the minimum in June to a maximum in September is noticed. Among the other years, in all the years prior to 1977 the maximum catches are

seen in the month of August and in the years after 1977 July shows the maximum catches of prawns except in 1981. The monthly input of effort also shows more or less the same trend, increasing steadily from June, reaching maximum in July or August and with the decrease in landings the effort also declines considerably by September. But in 1977 contrary to the regular increase of the catches from June onwards to September, recording the maximum catch in that month, the effort is maximum in August, resulting in a lesser effort bringing in higher catches in September or in other words a higher catch rate in the month. This is exceptional, but in all the other years the catch rate remains high either in August or in July.

Table 2. *Monthwise trawling effort and catch details at Sakthikulangara during the monsoon period from* 1973 to 1982

Year	Effort - No. of boat trips (Catch rate of prawns in kg/boat trip)					Prawn landings in tonnes (Percentage of prawns in total trawl-catch)				
	June	July	August	Sept.	Total	June	July	August	Sept.	Total
1973	15,157 (211)	19,443 (651)	17,799 (1235)	10,460 (67)	62,859 (613)	3,202.8 (53.1)	12,652.2 (83.4)	21,983.3 (85.3)	703.9 (32.8)	38,542
1974	16,002 (80)	8,722 (27)	20,525 (494)	30,117 (234)	75,366 (248)	1,283.0 (21.5)	235,2 (11.6)	10,140.7 (65.5)	7,038.9 (19.3)	18,698
1975	31,557 (67)	61,377 (235)	47,310 (671)	10,120 (31)	1,50,364 (319)	2,109.5 (19.3)	13,806.7 (31.0)	31,722.2 (57.7)	312.8 (11.6)	47,951
1976	8,080 (82)	3,426 (200)	19,721 (495)	12,217 (34)	43,444 (266)	665.0 (33.0)	685.0 (60.1)	9,768.2 (79.2)	419.8 (16.7)	11,538
1977	6,289 (38)	22,191 (150)	30,106 (264)	22,598 (432)	81,184 (262)	241.9 (15.7)	3,334.3 (32.3)	7,949.8 (40.2)	9,763.8 (73.9)	21,290
1978	26,083 (186)	28,039 (573)	41,030 (167)	35,375 (7)	1,30,527 (215)	4,849.7 (49.2)	16,068.1 (64.1)	6,855.9 (26.9)	243.7 (4.2)	28,017
1979	6,801 (132)	23,531 (396)	22,878 (90)	16,245 (10)	69,455 (179)	900.0 (45.3)	9,313.1 (63.5)	2,064.2 (14.9)	506.9 (7.7)	12,784
1980	16,342 (58)	35,681 (757)	21,904 (270)	25,484 (87)	99,411 (363)	946.1 (27.4)	27,012.1 (79.8)	5,903.8 (43.6)	2,208.1 (15.9)	36,070
1981	16,890 (80)	20,679 (119)	16,621 (208)	8,367 (21)	62,557 (119)	1,349.0 (36.0)	2,465.3 (29.0)	3,454.5 (59.6)	175.4 (89.9)	7,444
1982	19,594 (64)	18,063 (258)	18,436 (58)	10,615 (29)	66,708 (109)	1,246.3 (22.8)	4,653.2 (46.7)	1,069.8 (21.4)	308.7 (16.5)	7,278

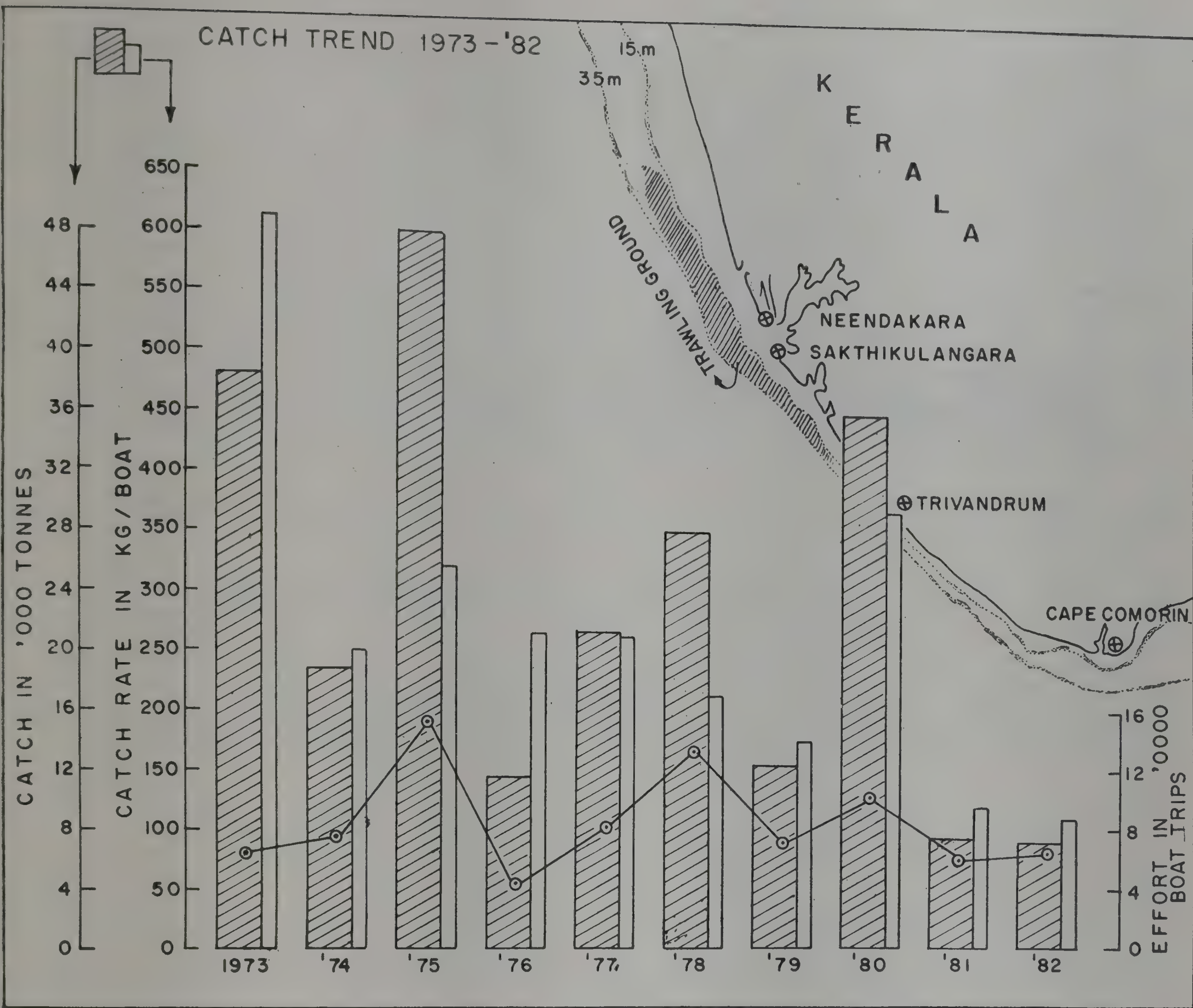


Fig. 1. Production trend of prawns at Neendakara during the monsoon periods of 1973 to 1982

Species composition and variation in abundance

The prawn fishery is supported by penaeid prawns only and that too mostly by one species. The catch composition of the prawn landings of the area during June to September period over the past 10 years is shown in table 3. *Parapenaeopsis stylifera, Metapenaeus dobsoni, M. monoceros, M. affinis* and *Penaeus indicus* are the species represented. *P. monodon, P. canaliculatus* and a few other species are represented rarely. On an average the percentage of *P. stylifera* (Karikkadi) over the years is 85.8, *M. dobsoni* 5.3, *M. monoceros* 4.4, *M. affinis* 1.8, *P. indicus* 1.8 and other species 0.9. As indicated in the earlier publication it is clear from the present study also that the fishery is mostly for *P. stylifera* and thus the fishermen and the industry has named the fishery as 'Karikkadi fishery.' In a period of 10 years only in the years 1973, 1975, 1979 and 1982 does the overall percentage of the species in the fishery go below 90. The least percentage of 70.8 was recorded in 1975 and the highest percentage of 95.7 in 1980.

It is interesting to note that among the less represented species the smaller and medium sized species of *Metapenaeus* which were present in comparatively higher percentages have come down considerably in 1981 and 1982, while in the large sized *P. indicus* the percentage which was very low in earlier years has gone up to 3.1 and 6.9 respectively in 1981 and 1982. This is one reason why in these years although the total quantity of prawns landed is considerably less the value realised does not show any serious decrease. The

increase in percentage of *P. indicus* (naran chemmeen) is especially noticed in the month of June when the seasonal fishery commenced. During 1982 season out of 1,246 tonnes of prawns landed at the centre in June, this species alone accounted for 35%. But in subsequent months the representation of the species declined considerably, *P. stylifera* taking up the place exclusively.

Fluctuations in catches

A day to day analysis of the total catches of the species landed at the centre (Fig. 2) shows that there is wide variation in the catches during the season. A study of the figure would indicate that very heavy catches occur only on a few days during the entire season and the magnitude of the fishery for the season mainly depends on the catches of these days. For instance in 1980 this really heavy catch, going upto 1700 kg per boat, occurs only in a few days in the latter half of July and this is reflected in the total catch for the season, reaching a comparatively high figure. On the contrary such high catches are never encountered on any day in the 1982 season, the catch per boat never rising above 400 kg with the result the total catch of the season keeps a very low profile. From the figure it seems that the effort put in is fairly high throughout the season, giving a comparatively low rate of catch per boat. This might probably indicate that the abundance of the

Table 3. *Catch composition of prawn landings at Sakthikulangara during the monsoon period (June-September) from* 1973 *to* 1982

Year	Landings in tonnes (species-wise percentage in parenthesis)						
	P. indicus	*M. affinis*	*M. monoceros*	*M. dobsoni*	*P. stylifera*	Other species	Total prawns
1973	234.7 (0.61)	1,719.7 (4.46)	4,403.6 (11.43)	141.9 (0.36)	31,951.6 (82.90)	90.6 (0.24)	38,542
1974	144.7 (0.77)	238.1 (1.27)	749.5 (4.01)	22.7 (0.12)	17,396.1 (93.04)	146.9 (0.79)	18,698
1975	2,164.7 (4.52)	799.6 (1.67)	2,015.7 (4.20)	7,484.2 (15.61)	33,960.4 (70.82)	1,526.7 (3.18)	47,951
1976	119.6 (1.04)	127.0 (1.10)	147.9 (1.28)	108.0 (0.94)	10,967.0 (95.05)	68.5 (0.59)	11,538
1977	168.7 (0.79)	41.6 (0.20)	1,535.3 (7.21)	—	19,442.6 (91.32)	101.7 (0.48)	21,290
1978	306.2 (1.09)	299.7 (1.07)	423.2 (1.51)	1,721.5 (6.14)	25,239.9 (90.09)	26.9 (0.10)	28,017
1979	78.0 (0.61)	304.5 (2.38)	334.6 (2.62)	1,847.3 (14.45)	10,205.7 (79.83)	14.1 (0.11)	12,784
1980	201.0 (0.56)	386.9 (1.07)	296.1 (0.82)	627.7 (1.74)	34,523.1 (95.71)	35.6 (0.10)	36,070
1981	229.5 (3.08)	77.9 (1.04)	102.6 (1.38)	72.2 (0.97)	6,864.0 (92.21)	98.1 (1.31)	7,444
1982	504.0 (6.92)	40.1 (0.56)	130.8 (1.80)	166.6 (2.29)	6,361.3 (87.40)	75.3 (1.03)	7,278

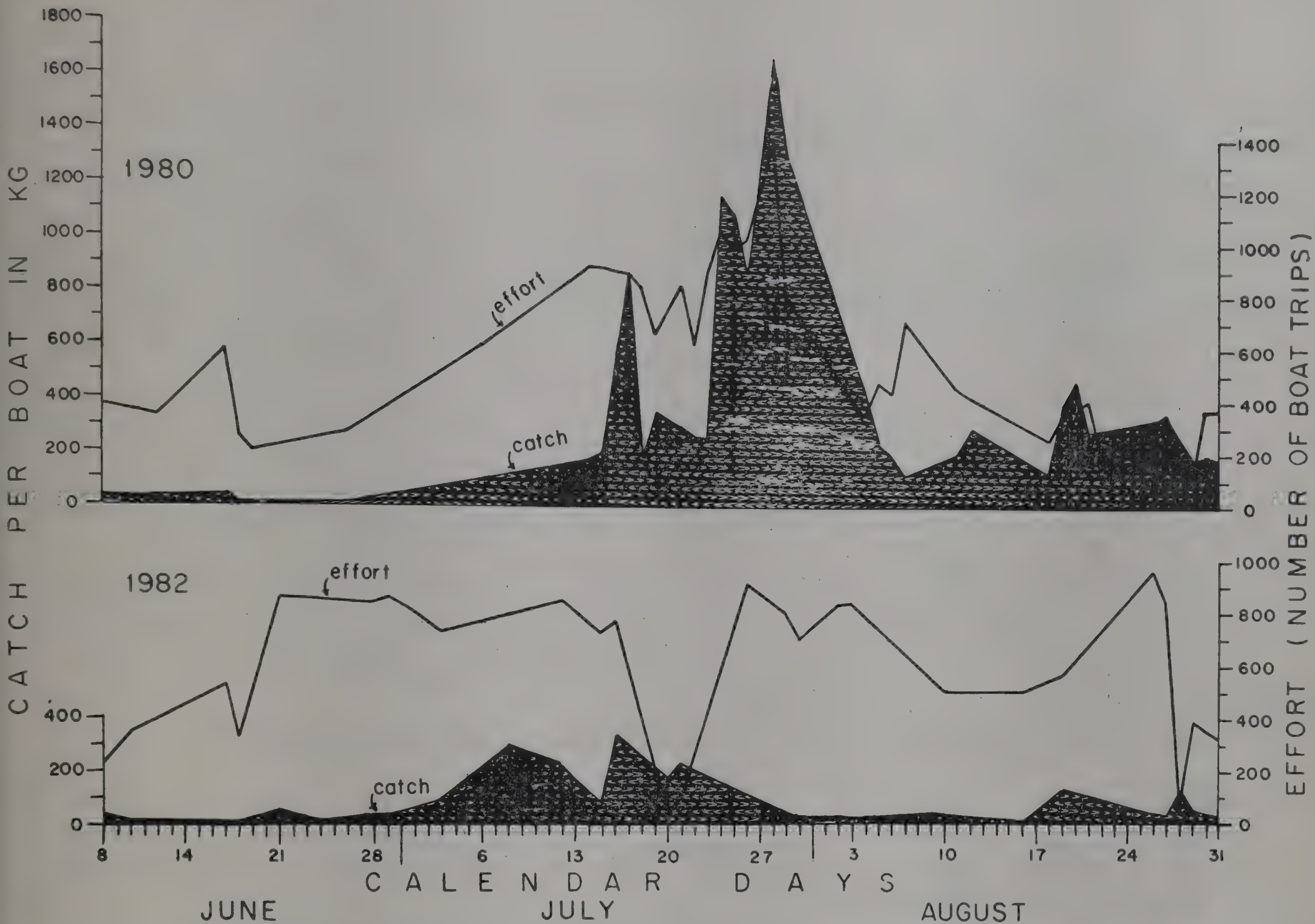


Fig. 2. Catch and effort details of *P. stylifera* on observation days during 1980 and 1982 seasons.

prawns in the particular area of operation of the boats is quite low throughout this season or in other words the stock size has gone down. The sudden fall in fishing effort on 20th and 21st July, 1982 was due to rough sea.

Size distribution

The sex-wise size distribution of *P. stylifera* recorded from June to August 1982 is depicted in Fig. 3. In the overall fishery the size, measured from tip of rostrum to that of telson, ranged from 32 to 103 mm in males and 33 to 115 mm in females. However, the bulk of the catch was made up by 56–95 mm of the former and 56–105 mm of the latter. The size preferred by the industry is normally above 65 mm and since the meat recovery below this size is extremely poor they are otherwise disposed. As could be seen from the figure the catch was mostly constituted by prawns above 75 mm in the beginning of the season and thereafter still smaller sizes entered into the fishery in substantial quantities. In fact, smaller sizes below 65 mm dominated the fishery towards the end of June and July, indicating fresh recruitment of juveniles into the area during that period.

The occurrence of undersized prawns in the fishery was studied in detail during the fishing season of 1981. Table 4 indicates the catch distribution of smaller and larger size groups of *P. stylifera* against the daily catch rates recorded during the observation days. Based on the sample analysis, for the whole season an average of nearly 30% of the catch in terms of number was constituted by smaller size groups below 65 mm. This works out to about 10.5% in terms of weight which, undoubtedly, is quite substantial in an exploited stock. It could be seen from the table that maximum quantities of the young prawns are caught during the period of peak catch rates recorded during the latter half of the season, especially towards the end of July when the catches are at the maximum. The number of smaller prawns caught on certain days during this period sometimes exceeds the larger sizes preferred by the industry and on those days it has been noticed that large quantities of the undersized specimens of the species mingled with small juveniles of fishes are discarded after sorting out the larger sizes. This is evident only on the days when the catches are really high, consequently rendering it

difficult for handling for the lady sorters and at least on those days some wastage of the young prawns is taking place in this area.

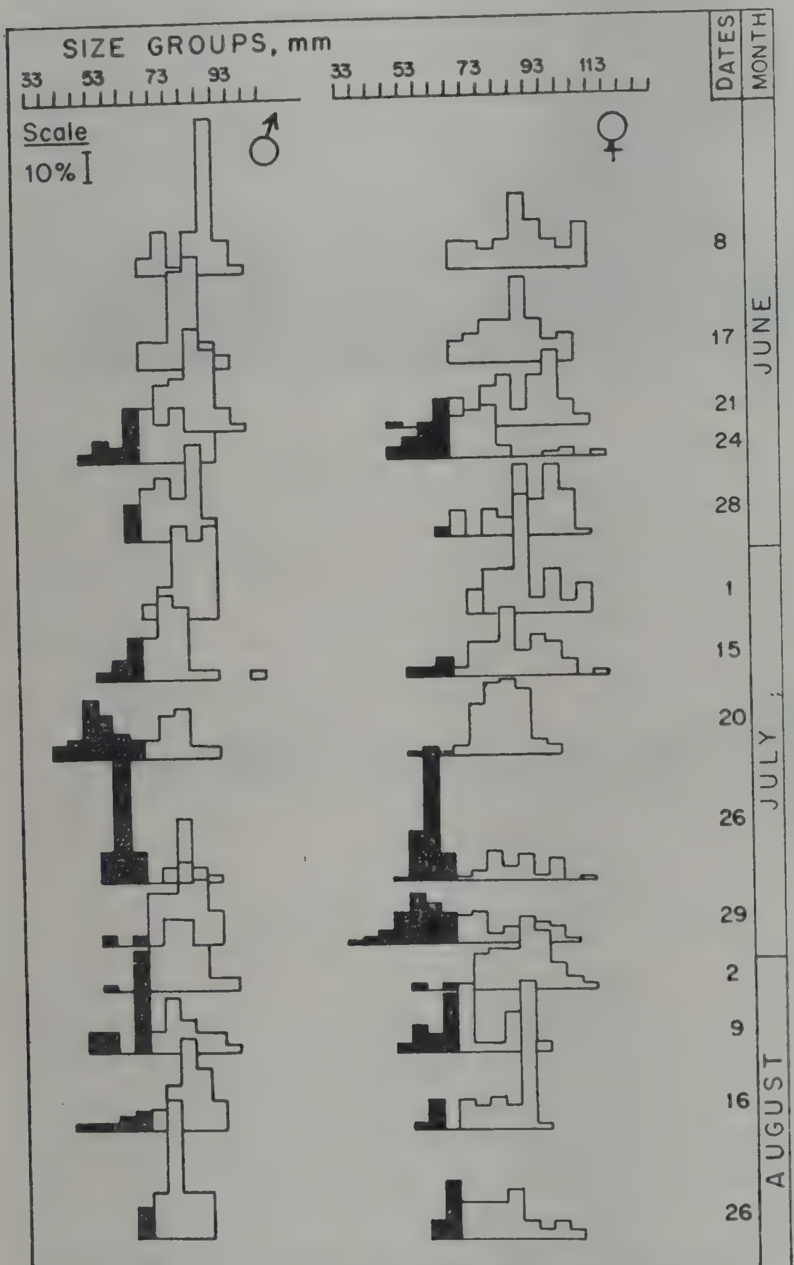


Fig. 3. Size composition of *P. stylifera* on observation days in 1982 season. Undersize groups are indicated in black.

Sex ratio

The general trend of the sex composition of the species in the fishery in 1982 was domination of males over females during major part of the season. From the 2nd to 4th week of July when the highest catch rates were recorded a steady decline in the number of females in the catch (48.8% to 25.3%) was noticed. The overall monthly sex ratio worked out to 56.5:43.5, 58.3:41.7 and 50.6:49.4 for June, July and August respectively with preponderance of males.

Spawning stock

Distribution of different maturity stages of the species was noted for females based on the ovary conditions. Normally the female prawn attains maturity when it is about 65–70 mm total length and the male at slightly smaller size. Throughout the period under investigation the female population included specimens of all maturity stages like immature, early maturing, late-maturing, gravid and spent-recovering. The proportion of late-maturity and gravid females, which can be easily detected from the thick greenish ovary visible through the exoskeleton, was not found to be of any significant level in comparison with the conditions prevailing during the pre-or post-monsoon periods. These stages formed only 17.3% in June, 10.4% in July and 21.8% in August out of the total females exploited by the trawlers. This would indicate that the fishery is not touching the spawning stock of the species at the peak period of the fishery.

Relationship of catch and rainfall

Relationship of prawn catches with rainfall has been indicated in certain areas by earlier workers. In the case of the prawn fishery of Neendakara area the very fact that the fishery is highly seasonal and occurring during the rainy monsoon season indicates that there is a relationship for this fishery with the rainfall. An examination of the rainfall data along with the monthly catches of prawns during the monsoon season for the period 1974 to 1982, as depicted in figure 4, indicates that there is a relationship between the peak fishing days and the peak of the monsoon rains. It is seen that, in general, the peak period of the prawn landings occur in the following month or the month after the heavily raining months. It is also noticed that in the years when there is maximum rains the prawn catches here also are relatively high, showing a direct relationship between the two.

Discussion

Among the interesting facts which emerge from the study may be pointed out that almost single species namely, *Parapenaeopsis stylifera* dominated in the fishery of the area. As mentioned in an earlier investigation (George *et al.*, *Mar. Fish. Infor. Serv. T & E Ser.* **18**:1-8, 1980) this dominant species is different from the species dominating in the mud bank or 'Chakara' fishery of the adjoining areas north of this particular fishing ground, the species dominating there being *Metapenaeus dobsoni*. It is all the more intriguing that Neendakara fishing

ground which is just outside the estuarine backwaters of the Ashtamudi lake supports a species which does not have an estuarine phase while the area north and farther away from the mouth of the same estuary supports the fishery of a species which uses the estuary as a nursery ground for its juvenile phase. It is probable that it is the nature of the substratum which brings about this peculiar distribution of the species in the fishery in adjoining areas.

both 1981 and 1982 the catch has reached the lowest minimum so far recorded, giving very poor catch rates. Nearly 75% reduction in the catch is noticed in these years as compared to 1980. The situation is quite alarming when viewed coupled with the fact that the input of effort during the period is kept fairly high, probably indicating thereby that the stock of prawns in the fishing ground has really gone down.

Table 4. *Percentage composition of smaller and larger size groups and catch rates of* P. stylifera *landed by shrimp trawlers at Neendakara during June-August* 1981

Observation days	Percentage ratio In number Below 65 mm TL	Above 65 mm TL	In weight Below 65 mm TL	Above 65 mm TL	Average catch/ boat In Kg.
June, 1981					
11-6-81	3	97	1	99	29.1
25-6-81	24	76	7	93	56.6
30-6-81	3	97	1	99	50.7
July, 1981					
13-7-81	18	82	6	94	137.3
20-7-81	12	88	4	96	171.7
21-7-81	31	69	11	89	46.6
22-7-81	40	60	20	80	216.7
23-7-81	56	44	22	78	226.0
28-7-81	45	55	18	82	14.0
30-7-81	30	70	8	92	1357.0
August, 1981					
6-8-81	30	70	4	96	24.5
7-8-81	34	66	11	89	35.7
10-8-81	38	62	14	86	79.3
24-8-81	34	66	12	88	243.7
25-8-81	47	53	19	81	124.5
28-8-81	26	74	8	92	4.3

TL—Total length measured from tip of rostrum to tip of telson

The investigation mentioned earlier has established that economic overfishing of prawns is taking place in Neendakara fishing grounds. The data on prawn catch and effort during the subsequent years included in the present study confirm this conclusion. Although there was increase in total catch in 1980, subsequently in

Implementation of some effective conservation method seems to be very essential here for the proper management of the fishery. The State Government is advised to take prompt action in the matter before it is too late, so as to prevent any further decline in the fishery which contributes to the shrimp exports from

the state to a very large extent. Taking all aspects into consideration, both biological and economical, the possible management approach which could be advised in the particular fishery may be any one of the two

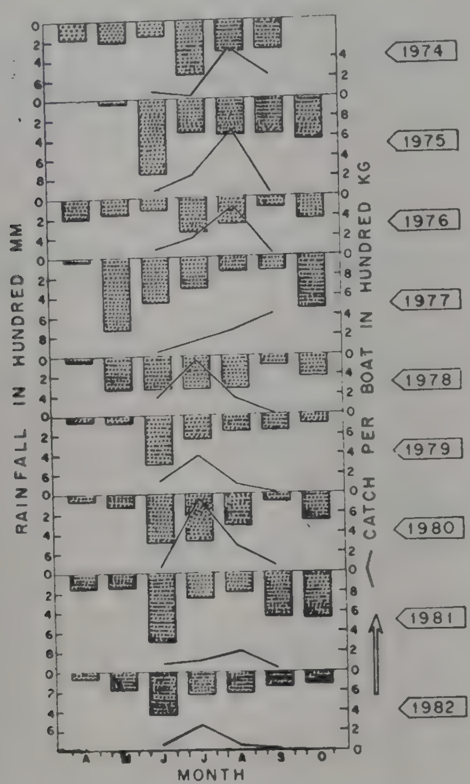


Fig. 4. Relationship between prawn catch and rainfall (shown as shaded) at Neendakara (1974–1982).

methods mentioned below or a combination of both. As indicated in an earlier publication, the most suited method seems to be the restriction of the input of effort in the particular area by limiting the number of vessels in operation through proper licensing and restricting of entry of boats from other parts of the country. Since the peak season fishery is mostly contributed by a single species and very small sizes are fished in large quantities on certain days during the season, the regulation of mesh size of the nets in operation at a higher size than at present is the other method which could be used with advantage. In any case immediate attention of the authorities concerned is required for managing the fishery properly.

At the same time another point worth mentioning here which gives hope for the future, is that the study of the maturity conditions of the species fished shows that at no time during the season does the spawning population of the species appear in real high abundance. Added to that in the sex ratio a preponderance of males is noticed all the time. These might be pointers to the existence of a spawning population of the same species somewhere outside the area where the present fishing operations are carried out. The constant recruitment of younger specimens of the species in the fishery, often in larger quantities and sometimes discarded by the industry when the catches are very high, further strengthens this view. Exploratory cruises being planned to be conducted in the area during the fishing season would probably throw more light on the source of recruitment of the species and the factors influencing the dynamics of the population.

ACIDITY IN VEMBANAD LAKE CAUSES FISH MORTALITY

V. K. Pillai, A. G. Ponniah, D. Vincent and I. David Raj

The sudden changes of variations in the environmental and climatic patterns in an area always cause certain undesirable and unforeseen events as well as problems. The severe drought conditions experienced in South India, especially in the state of Kerala during the summer of 1983 was such an unusual incident. Added to that the monsoon, this year, commenced late. Immediately after the first monsoon rains, in the third week of June, an instance of mass mortality of fishes and clams was reported from the Vembanad Lake. The report indicated that large scale mortality of several groups of aquatic organisms were occurring mainly in the southern half of the lake. Indications were that the phenomena started from the southernmost region and slowly spread to the north. Although, immediate reaction was to look for industrial pollution, the same was ruled out by undertaking immediate monitoring near the major industries situated in the vicinity. Personal discussions with several local farmers, and agricultural and soil scientists working in the region indicated that the unusual phenomena might have been caused by soil acidity. Hydrogen-ion concentration of the water showed that it was in acid range. However, the vast area of the lake affected as well as the quantity

of acid required to effect such a lowering of pH (the pH showed a 50% reduction compared to the normal range) was rather a puzzle which prompted the scientists of CMFRI to undertake a detailed monitoring of the whole area extending from Aroor to Alleppey.

The environment

The Vembanad Lake, situated in the south-west coast of India, connected to the sea through the Cochin backwaters is well known for its fishery resource as well as for its role as a nursery ground for the commercially important crustacean fishery resources. The portion of the backwater system that extends from Cochin to Alleppey covering an area of about 80 sq.km. is generally known as the Vembanad Lake which is primarily connected with the Kuttanad region. The waters of the Vembanad lake is subjected to the flood waters emptied by the river systems and also to the sea water entering into the lake on account of the tidal action. The Vembanad Lake and the backwater system exert considerable influence on the ecology of the surrounding areas.

Four major river systems of Kerala, viz; Meenachil, Manimala, Pamba and Achancoil feed the region with an annual discharge of 11106 M m^3. The discharges of the river systems that enter into the Lake pass through Thanneermukkom barrage. During the S.W. monsoon, usually the discharge from the lake reaches a peak of 65 thousand cusecs (1840 m^3/sec).

Ecology

The ecology of the area with respect to the ability to sustain life, both on land and in water, is conditioned by salinity which in turn is controlled by the combination of flood waters and sea water entering the Lake. The wide spectrum of divergence in salinity, from sweet water to sea water, enables to sustain a wide variety of aquatic life, both plant and animal, in the water. An ecological balance has been struck over the period of its evolution with a combination of plant and animal life.

Geology

In the geologic past, it is believed that the entire area of Kuttanad was part of the shallow coastal area adjoining the Arabian sea. The silt carried by the rivers got deposited at the river mouths giving rise to the present coast and converting the shallow bay into an extensive lake-lagoon-backwater system. The lagoons and lakes gradually silted up and gave rise to sedimentary formations which were eventually converted into garden lands and wet lands by the gradual process of reclamation which now characterises Kuttanad. The deeper portions of the backwaters form the Vembanad Lake which extends from Alleppey in the south to Cochin in the north.

Soil characteristics

Soils of this region may be grouped into three categories viz. (1) Kayal soils (2) Karappadom soils and (3) Kari soils.

1. *Kayal soils:* These are found in the reclaimed lake bed in Kottayam and Alleppey Districts and they occupy an area of about 8,000 hectares. The land is situated 2 to 3 metres below the sea level. The soils are slightly acidic to neutral in reaction, very low in organic matter content, poor in total and available plant nutrients, but are fairly rich in Calcium. As they are seriously affected by salinity, crop failures are common in them.

2. *Karappadom soils:* These soils occur along the inland water ways and rivers and are spread over a large part in the upper Kuttanad covering an area of about 41,000 hectares. They are river borne alluvial soils. The fields lie in about 1–2 metres below sea level. The soils are characterised by high acidity, high salt content and a fair amount of decomposing organic matter. They are generally poor in available plant nutrients, particularly so in phosphorus. They are also highly deficient in lime. Infertility is the more serious problem in these soils.

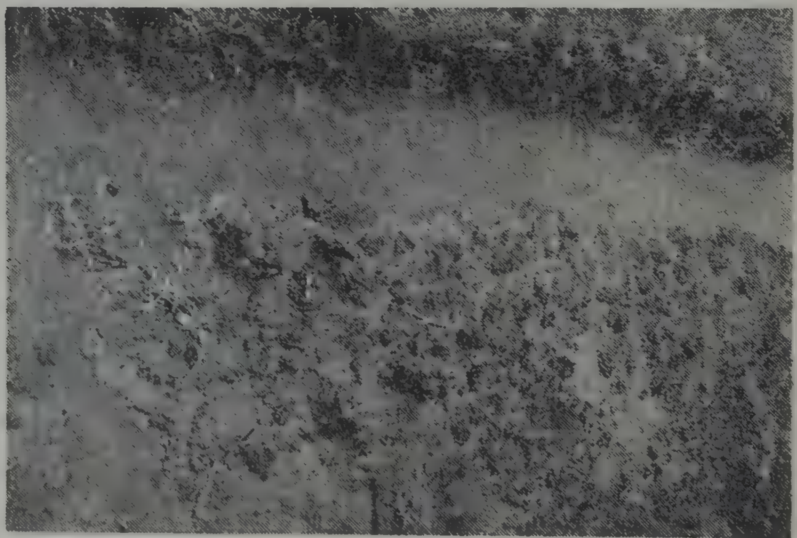
3. *Kari soils:* These are peat soils found in large isolation patches in Alleppey and Kottayam Districts, covering an area of about 20,000 hectares. They exhibit characteristics of submerged forest area, but are not silted up. Deep black in colour, the soils are characterised by heavy texture, poor aeration, bad drainage and low content of available plant nutrients. They are affected by saline intrusion with consequent accumulation of soluble salts. They are also highly acidic in reaction. In these soils free sulphuric acid is formed by the oxidation of sulphur compounds present in the wood fossils found under the soil. Large amounts of woody matter at various stages of decomposition occur embedded in these soils.

The Kari and Karappadom soils record pH below 5.0 under moist condition. The pH of these soils is found to decrease on air drying. The maximum pH

1

3

PLATE I. 1. Collection of samples
2. Dead clams collected by fishermen.
3. A typical kari soil field.
4. Close up of acid water leaching from the soil.
5. The water being pumped out from big paddy fields.



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values of these soils are observed during September-October. On exposure of the soils during crop season the pH progressively decreases and reaches the minimum at post-harvest period, February–March. The seasonal variation is more marked in the Kari and Karappadom soils than in the Kayal soils. The Kari and Karappadom soils resemble the typical acid sulphate soils in several characters. Changes in oxidation reduction potential, oxidation of sulphur compounds under aerobic conditions and subsequent hydrolysis under anaerobic conditions of water logging with the production of mineral acids would all collectively contribute to a decrease in pH on drying (Money and Sukumaran, 1973). They also observed that either air-drying or sun-drying in the field drastically decrease the pH of the Kari and Karappadom soils. This aspect of the soil is significant in the context of cropping pattern, and water management.

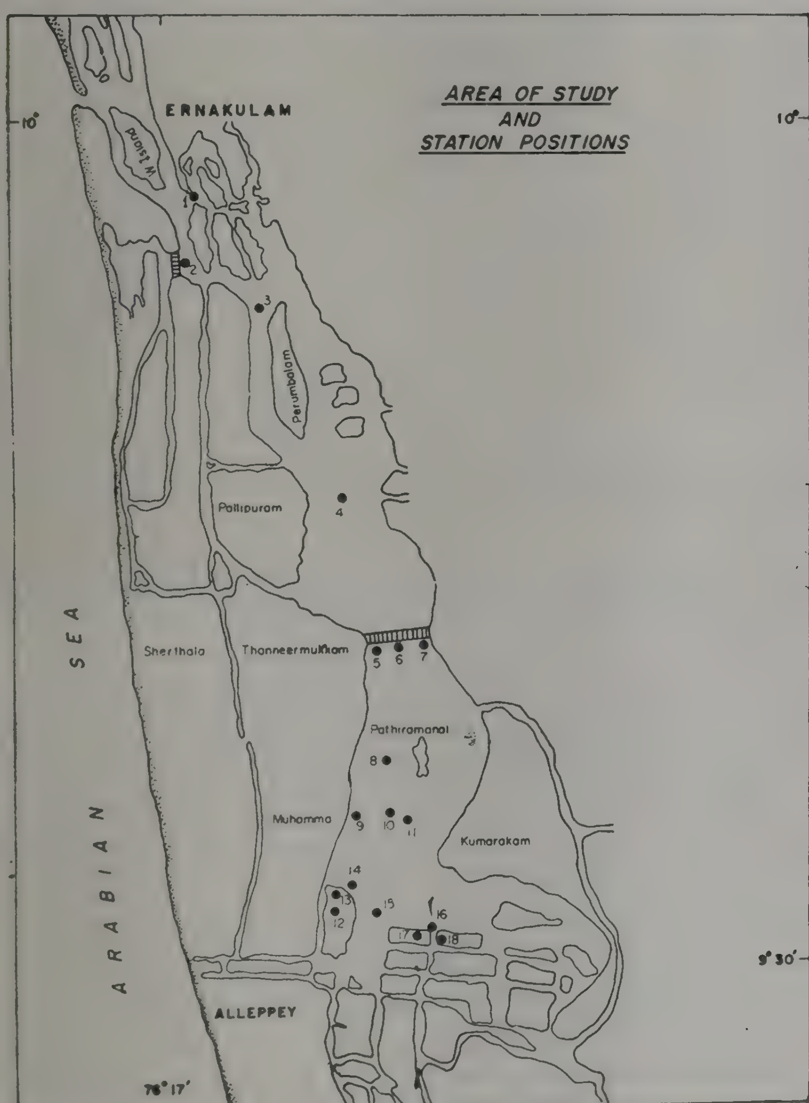

Fig. 1. Map showing the station position.

Observations

This report contains the results of investigations conducted by the Institute on the causes, effects and problems of this unusal phenomena. The details regarding the station positions from which samples were collected and analysed are given in Fig. 1. In order to identify the cause of the phenomena, water samples were collected at different transects covering an area of about 65 km from Aroor to Alleppey. In addition, samples were also collected from the paddy fields bordering the southern tip of the lake and also from the Muvatupuzha river where a major newsprint factory is located. Water temperature and pH were recorded from all the stations. Samples were also analysed for salinity, dissolved oxygen and ammonia.

The team investigating the phenomena monitored the water characteristics over the lake surface and adjacent waters to determine the causative factor and also to record the recovery in the situation during the course of a months time. It was found that in the middle region of the lake where the mortality occurred, lower salinity values were recorded (Table 2) indicating that the area was under freshwater regime. The recorded dissolved oxygen values were within the normal range that could support aquatic life. Very high values of ammonia were recorded in the area where extensive mortality had occurred (Table 3). The source of this high ammonia could be due to the pumping of water from the paddy fields where fertilizers had been used during the last season. But this high levels of ammonia could not have been a causative factor for the mortality of fishes since at low pH the ionization of ammonia will be considerably reduced thereby reducing the lethality of ammonia.

Among the parameters studied, pH showed low values on the acidic range. Most of the pH values recorded were in the range of 3.0 to 7.0 against the normal range of 7 to 8. Details are given in Table 1. On the first day of observation (28–6–'83) at Thaneermukkom the pH recorded was 3.65 and 2 km away (towards south) the same was 4.85. It was significant to note that during the initial sampling time the pH of the water collected from the paddy fields as well as from the open waters at the southern end of the Vembanad Lake recorded very low pH (4.0), especially the water pumped out of the paddy fields (pH 3.8). The paddy fields of Kuttanad are 1 to 2 m below the lake water level. Hence for preparing the fields for cultivation as well as for regulating the water flow during the cultivation, pumping of water is regularly practiced. The size of the pump and the quantity of water pumped out naturally depends on the size of the field, invariably extending to several thousand hectares. All these

Table 1. *Variation in pH in space and time*

Dates of collection	30.6.83 & 1.7.83		4.7.83		16.7.83		1.8.83		6.8.83	
Stations Location	S	B	S	B	S	B	S	B	S	B
1. Thevara	7.59	—	—	—	5.88	—	6.95	—	6.55	—
2. Aroor	4.80	6.44	—	—	5.18	5.70	5.55	—	6.22	—
3. Arookutty	6.22	6.44	—	—	5.88	6.10	6.55	6.40	5.88	6.07
4. Manalpuram	3.68	4.09	—	—	4.21	4.35	—	—	5.60	5.40
Thanneermukkam bund										
5. Western end	3.84	3.85	4.34	—	4.35	—	5.78	—	5.48	—
6. Middle	3.81	3.92	—	—	5.55	—	5.55	—	4.68	—
7. Eastern	3.99	4.06	4.03	—	4.25	—	5.77	—	4.30	—
8. Kaypuram	4.00	4.30	—	—	5.30	5.41	6.00	6.15	5.48	5.50
Muhamma										
9. Near shore 1	3.97	4.38	3.88	—	4.08	3.94	5.69	5.46	5.23	—
10. Near shore 2	—	—	—	—	3.85	3.83	5.92	5.50	—	—
11. Middle	3.97	4.11	—	—	3.85	4.00	5.78	5.65	—	—
Punnamada										
12. Cultivated fields	—	—	3.90	—	4.78	—	5.50	—	4.90	—
13. Canal connecting fields	3.90	—	3.80	—	3.70	—	5.40	—	4.80	—
14. Backwaters 1	4.00	—	3.90	—	4.30	—	5.40	—	5.33	—
15. Backwaters 2	4.00	4.20	—	—	—	—	—	—	5.47	5.45
East of Punnamada										
16. Backwaters	3.18	—	—	—	—	—	—	—	4.24	3.93
17. Cultivated fields	3.80	—	—	—	—	—	—	—	3.90	—
18. Fallow fields	—	—	4.41	—	—	—	—	—	4.83	—

water ultimately reaches the lake. However, during thr peak of the summer this year, the level of water in the lake and canals were reportedly lower than in the fields beforc the on set of the rains.

During the initial samplings it was observed that to reduce the acidity of soil which was damaging the crops, continuous flushing was carried out by allowing the lake water into the paddy fields and then pumping it out. This process added to the water acidity caused from the natural run-off from the dry fields and canals through the rivers to the lake. In certain very large paddy fields (blocks) the water remained stagnant during the summer due to non-cultivation for the last one or two seasons. It was noticed that in these fields pH was rather low (3.8 ± 0.53). Even one month after the reported fish mortality in the lake, a few fishes were found dead and floating in these fields.

From the present study it can be conclusively said that the high mortality was only due to the low pH in the water. This low pH was mainly due to the leaching out of acid waters from the paddy fields and adjacent canals.

The data revealed that the effect of pH reduction seemingly influenced the eco-system only upto the middle of the lake and coming towards the mouth of the estuary the effect appeared to have got neutralized, probably due to the regular tidal action. However, even after a month or so from the period of initial impact, there was not much change in the situation in the affected area. The fact that, though during the latter field trips the acidity was found reducing slowly, still low pH persisting in the southern area even after a months time indicated beyond doubt that the real causative factor for the low pH originated from the soil acidity. It is also reported that mineral acids were usually responsible for excessively low pH. The common mineral acid in natural water is sulphuric acid which results from the oxidation of iron pyrite (Boyd, 1982). The reason for the persisting low pH could be that the river water input into the

Table 2. *Variations in Salinity in space and time (‰)*

Dates of collection		30.6.83 & 1.7.83		4.7.83		16.7.83		1.8.83		6.8.83	
Stations	Location	S	B	S	B	S	B	S	B	S	B
1.	Thevara	7.38	—	—	—	0.21	—	3.88	—	1.36	—
2.	Aroor	6.48	9.83	—	—	1.10	0.28	1.19	—	1.40	—
3.	Arookutty	10.76	11.28	—	—	2.95	3.95	1.89	2.71	0.87	1.00
4.	Manalpuram	5.10	5.11	—	—	1.17	1.15	—	—	0.44	0.35
	Thanneermukkam bund										
5.	Western end	3.80	3.28	2.26	—	1.05	—	0.30	—	0.42	—
6.	Middle	4.27	5.11	—	—	0.94	—	0.35	—	0.42	—
7.	Eastern	3.54	3.35	—	—	0.63	—	0.35	—	0.37	—
8.	Kaypuram	3.37	4.70	—	—	0.49	0.47	0.21	0.17	0.25	0.30
	Muhamma										
9.	Near shore 1	4.24	5.00	—	—	0.51	0.51	0.34	0.18	0.26	0.28
10.	Near shore 2	—	—	—	—	0.47	0.47	0.21	0.19	—	—
11.	Middle	0.81	0.32	—	—	0.49	0.50	0.21	0.19	—	—
	Punnamada										
12.	Cultivated fields	0.98	—	0.99	—	0.50	—	0.29	—	0.50	—
13.	Canal connecting fields	1.82	—	1.16	—	0.66	—	0.35	—	0.54	—
14.	Backwaters 1	0.71	—	0.64	—	0.29	—	0.21	0.19	0.19	—
15.	Backwaters 2	0.48	0.50	—	—	—	—	—	—	0.12	0.12
	East of Punnamada										
16.	Backwaters	2.54	—	—	—	—	—	—	—	0.49	0.49
17.	Cultivated fields	5.09	—	—	—	—	—	—	—	0.67	—
18.	Fallow fields	—	—	—	—	—	—	—	—	0.49	—

lake after several spells of monsoons showers has not been sufficient to flush the acids produced at the water-soil interface continuing for several weeks as the monsoon this season had been weak and halting in the initial period.

Though there are fishes that are exceptionally tolerant to low pH of upto 3.5 (Dunson *et al.*, 1977), many other investigators have found pH 5 as the lowest tolerant limit for freshwater fishes (Jones, 1964; Cooper and Wagner, 1973). For crustaceans, the lowest tolerant limit has been found ranging from 4.5 (Havas and Hutchinson, 1982) to 5.5 (Leivestad *et al.*, 1976). The present observation revealed that it took nearly 30 days for the pH to reach 5 in the affected region south of Thanneermukkom barrage. Irritation to the eyes reported by the divers doing clam fishing and redness of the eyes of fishes caught, indicated the continuous effect or acidity.

From the literature, it is apparent that many aquatic organisms are physiologically unable to tolerate conditions of high acidity (Havas, 1981). By experimental studies it has been established that at least four major physiological functions are altered at low pH. This includes calcium and sodium regulation,respiration and acid base balance. Several studies have revealed that anoxia and sodium depletion result when fishes are exposed to acid waters. (Packer and Dunson, 1972; Dunson *et al.*, 1977; Leivstad and Muniz, 1976; Ultsch and Gros, 1979. During our observations from the middle of July onwards dead as well as dying young ones of cat fish *Keletius* sp. (total length 63–83 mm)

Table 3. *Spacial and temporal distribution of ammonia (ppm)*

Dates of collection		30.6.83 & 1.7.83		4.7.83		16.7.83		1.8.83		6.8.83	
Stations	Locations	S	B	S	B	S	B	S	B	S	B
1.	Thevara	6.07	—	—	—	0.88	—	0.32	—	1.63	—
2.	Aroor	1.07	1.02	—	—	0.60	0.47	0.31	—	0.49	—
3.	Arookutty	0.54	0.40	—	—	0.96	1.06	0.24	0.31	0.49	0.30
4.	Manalpuram	1.28	1.28	—	—	0.75	0.73	—	—	0.29	0.28
	Thaneermukkam bund										
5.	Western end	1.26	1.25	0.84	—	0.89	—	0.32	—	0.30	—
6.	Middle	0.65	1.02	—	—	0.78	—	0.32	—	0.33	—
7.	Eastern	0.91	1.04	0.84	—	0.51	—	0.33	—	0.34	—
8.	Kaypuram	1.05	1.64	—	—	0.86	1.11	0.33	0.28	0.26	0.26
	Muhamma										
9.	Near shore 1	1.53	1.65	—	—	0.89	1.11	0.32	0.35	0.26	0.28
10.	Near shore 2	—	—	—	—	0.95	0.98	0.26	0.26	—	—
11.	Middle	0.09	1.53	—	—	1.88	1.11	0.24	0.24	—	—
	Punnamada										
12.	Cultivated fields	0.51	—	0.59	—	0.66	—	0.49	—	0.19	—
13.	Canal connecting fields	1.32	—	0.42	—	0.95	—	0.65	—	0.74	—
14.	Backwaters 1	0.51	—	0.52	—	0.60	—	0.24	0.30	0.10	—
15.	Backwaters 2	0.36	0.33	—	—	—	—	—	—	0.07	0.05
	East of Punnamada										
16.	Backwaters	0.54	—	—	—	—	—	—	—	0.31	0.49
17.	Cultivated fields	0.42	—	—	—	—	—	—	—	0.67	—
18.	Fallow fields	—	—	1.51	—	—	—	—	—	0.32	—

were observed. The dying fishes were found gasping and struggling at the surface indicating anoxia.

Except for the immediate mortality to fishes (like rays, *Etroplus* and *Mugil*), crustaceans (mainly crabs *Scylla serrata* and *Macrobrachium* sp.) and clams (*Villorita* sp.) the subsequent incidence of mortality were rather limited to the young ones of cat fishes (*Keletius* sp.). During the latter period of survey it was observed that there was limited fishing activity mainly for *Etroplus*. However, the destruction to the clam beds (*Villorita* sp.) is massive. Even after a month from first reports, there was not a single live clam specimen available in the southern half of the lake beyond Thanneermukkom. Subsequent monitoring of the water acidity showed that the effect is getting reduced, although the process is rather slow, it may take a few more months for the ecosystem to be back to maintain the normal balance of equilibrium between the environment and the living organisms.

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ACETES SHRIMP RESOURCE OF ANDAMAN AND NICOBAR ISLANDS*

Acetes indicus, locally known as 'Bushy Jhinga", occurs in the creeks, low lying areas and mangrove swamps of the Andaman and Nicobar Islands in large quantities. The genus *Acetes* Milne Edwards is represented in the mainland of India by five species, of which *A. indicus* is the most common and forms a fishery in the estuaries of Bengal, Maharashtra, Gulf of Kutch and Tamilnadu. This species is reported to have a distribution from the Indian Seas through Mergui Archipelago and Gulf of Siam to the East Indies. The information collected on *Acetes* resources in the Andaman and Nicobar Islands during a survey conducted there in February–April 1978 is presented here.

Areas of abundance

Acetes indicus is found to occur in the Andaman and Nicobar Islands in large swarms in the following areas: Landfall Island, Ariel Bay, Kalpong creek, Austin creek, Ray hill area, Bacon Bay, (Fig. 1 & 2), Kalapathar river, Parangara river, Balmi creek, Aves Island, Stewart Island, Rangat Bay, Long Island, Yerratila Jig, North of Baratang Island, Kyd Island, James Island, Mayo Island, creeks around Port Blair, Burmanalla, Chiriyatapu, swamps of Rutland Island; in Dugong creek, Mommunulla, Jackson creek, and South Bay, in Little Andaman. It is also found to occur in the marshy areas of Trinkat Island, Nancowry Island, Katchall Island and in the estuaries of the Calathea river and Alexandria river of Great Nicobar.

Fishing gears

Fishing is mainly carried out by one or two persons with or without a canoe. The net is made of mosquito netting with a wing portion and a bag-like cod end measuring 2 m in length. Two bamboo poles 2 m long, are used to make a triangular opening at the anterior and to give support to the sides of the net. (Fig. 3). The posterior ends of the poles which overlap each other

* Prepared by R. S. Lalmohan

Figs. 1 & 2. Acetes fishing areas in Bacon Bay with two Karens, the Burmese Settlers.

Fig. 3. Bushy jhinga net with two Karens of Mayabunder.

Fig. 4. Bushy jhinga kept for drying in Kyd Island, Middle Andaman.

serve as a handle to push the net from behind by a person wading in the water. The net is quite similar to the 'Dhobbu Vala' used in Kakinada (Andhra Pradesh) to catch prawns in the creek, reported by Ramamurthy and Muthu (CMFRI Bulletin No. 14: 1969). In Baratang area and in Middle and South Andaman Islands stationary bag nets and stake nets with mesh size 2 mm are also used by the fishermen.

Fishing season

It is gathered that *Acetes* forms a fishery from May to July and October to February, appearing in large swarms.

Species association

In a sample collection made from Bacon Bay, although it was during the off season for the shrimps,

Acetes indicus contributed 46.2%, followed by *Metapenaeus monoceros* (47.0%), *Penaeus merguiensis* (4.5%), *Mugil* spp. (1.6%) and *Ambassis* spp. (0.7%). In Kyd Island about 80% of the catch was that of *Acetes indicus* and *P. merguiensis* and 2% *Mugil* spp. When compared to areas where *Acetes indicus* forms a major fishery this is quite significant. Along Maharashtra coast on the mainland where *Acetes indicus* contributes to a good fishery the percentage representation of the species in the prawn landings is 20 to 30.

Utilisation

Based on enquiries it has been estimated that about 25 tonnes of 'Nappi' a preparation made from *Acetes*, is sent annually from Andamans to Nicobar. The Karens and Nicobaris living in Andamans use this preparation with rice. The 'Nappi' has the following composition: Moisture-40.4%, Protein-35.0%, Ash-22.0%, Acid insoluble-2.4% and Liquid-0.2%. A good quantity of *A. indicus* is consumed fresh and also after sundrying (Fig. 4).

Remarks

Although 'Bushy Jingha' is exploited to a certain extent by the local fishermen with their traditional gear, it is quite evident that there is no organised effort for the harvesting of this rich resource. The level of production can be increased considerably with an organised exploitation by using proper craft and gear and at the right time. Side by side proper utilisation also has to be thought of by improving the marketing facilities for 'nappi' and other products.

ALFALFA PROMOTES GROWTH IN PRAWNS*

Introduction

In recent years, culture of prawns in ponds and paddy fields has attained much importance as a means of augmenting production of these crustaceans for export. In this context, it was thought worthwhile to have investigations to enhance the growth of prawns using different anabolic chemicals/agents. Alfalfa, a known growth promoter was added to the supplementary feed and experimented with juveniles of *Penaeus indicus* in the laboratory and in the field culture ponds as well. The present report deals with the results of the experiments to assess the impact of Alfalfa on the growth rate of prawns.

Growth promoting agents

Certain classes of chemical compounds such as antibiotics, vitamins, hormones, arsenicals, tranquillisers and surfactants have been reported to stimulate the growth of animals. Recently the use of some chemicals has been found to enhance the production of Indian major carp fry and fingerlings (Sen, P. R. and D. K. Chatterjee, 1979). Enhancing production of Indian major carp fry and fingerlings by the use of growth promoting substances. *Advances in Aquaculture*,

* Prepared by D. S. Rao, P. P. Pillai, K. J. Mathew, K. Rengarajan, D. Vincent and L. R. Khambadkar

FAO Technical Conference on Aquaculture. Fishing News Books Ltd., Farnham, Surrey, England, pp. 134–141). The chemicals used included Proloid, Eltroxin, Berin, Macrabin, Vitamin B complex, Yeast, Starch, Selenium, Molybdenum, Boron, Cobalt chloride, Enterocycline, Chloromycetin, Hoestacycline and Manganese. They found that Cobalt chloride, Starch, Boron and Manganese significantly enhanced the survival rate.

Role of Alfalfa

The leguminous forage plant known botanically as *Medicago sativa* commonly known as lucerne, alfalfa, purple medick or chilean clover, is known to be a good source of vitamin K. The exact function of vitamin K in the metabolism of animals is unknown, although it has been postulated that it is a fat soluble, thermostable compound essential for the formation of normal amounts of prothrombin which diminishes the clotting time of blood. Unlike other grasses, Alfalfa does not possess large amount of reserve polysaccharides in the form of fructosans, but it contains small amount of starch and large quantities of pectin. The protein content is high and if the crop is cut in the early flowering stage the crude protein content is above 20%. Alfalfa is a valuable source of the element Magnesium (0.20–0.36%). Many forage plants are known to contain plant estrogens which in limited amounts, have a beneficial effect on the fattening of animals similar to that of giving synthetic hormones such as stilbestrol and hexestrol. Alfalfa has been found to contain such estrogenic substances (McDonald, P., R. A. Edwards, J.F.D. Greenhalgh 1973. *Animal Nutrition.* Longman, London, pp. 357-358).

As early as 1933 Chibnall A. C., E. F. Williams, A. L. Latner and S.M. Piper (1933. *Biochem. Jl.*, 27, pp. 1885–1888) had isolated the principal chemical component of Alfalfa wax, as n-triacontanol, M.p. 86.3 – 86.5°. Triacontanol is insoluble in water, soluble in acetone, ethylacetate and benzene and crystallises in the form of lustrous plates M.p. 86.5°. Triacontanol was isolated from waxes (Robinson, 1934. *J. Chem. Soc.*, p. 1545). It was shown that triacontanol was the active material of Alfalfa grass which resulted in higher yields of crops when sprayed in minute quantities (Stanley, K. R. 1975). In view of the above, it was decided to investigate whether Alfalfa can be of any effect to enhance the growth in juvenile prawns.

Experiments

Juveniles of prawn *Penaeus indicus* were reared both in aquarium tanks in the laboratory and culture ponds in the field at Neendakara simultaneously.

In the laboratory, duplicate aquarium tanks of 30 x 70 x 35 cm size were selected of which one served as control and the other as experimental unit. 30 litres of water having salinity of 20‰ was taken in each container. The juvenile prawns were brought to the laboratory and after acclimation for 10 days the healthier ones of almost same length and weight were separated, the initial size (both length and wet weight) were recorded and stocked at the rate of 40 prawns per tank. The duration of the experiment was 35 days during which the environmental parameters such as temperature, light, pH, dissolved oxygen were kept almost identical in both control and experimental units. About 50% of water in both the units was changed every day. The average temperature in the aquarium tanks in the laboratory during the experiment was 30.07°C, the fluctuation during the period was within ± 1.5°C. The average salinity fluctuation in the experimental as well as control tanks was within ± 1.5‰. The dissolved oxygen was kept at 4.5 ml/l by aeration except foı one day due to power failure when there was mortality.

Table 1. *Details of Alfalfa incorporated in the supplementary diet and fed the prawns in experimental tank at the laboratory and in the culture pond. Prawns in the control tank and culture pond were also fed with supplimentary diet without Alfalfa.*

At the laboratory		At the field	
Week	Quantity of Alfalfa (gm)	Fortnight	Quantity of Alfalfa (gm)
1st	0.011	1st	0.4375
2nd	0.011	2nd	0.5250
3rd	0.070	3rd	0.6125
4th to 7th*	0.105	4th	0.7000

* The amount of Alfalfa in the feed was kept constant from 4th week due to mortality of experimental prawns due to insufficient aeration caused by power failure.

In the field, two identical and adjacent culture ponds of 0.024 ha were selected of which one was kept as control and the other for experiment. The juvenile prawns were stocked in the ponds at a density of 0.104 million/ha. The average conditions of temperature, salinity and dissolved oxygen at the surface were 33.8°C,

Table 2. *Details of experiments conducted by rearing the juvenile prawns in tanks at the laboratory and in culture ponds at the field*

	Laboratory Experimental	Laboratory Control	Field Experimental	Field Control
Initial				
Number of specimen	40	40	2,500	2,500
Size: Mean length (mm ± S.D.)	33.75 ±3.98	33.22 ±3.43	32.0	32.5
Size: Mean weight (gm)	0.286	0.280	...	...
Duration of Experiment (days)	35	35	48	48
	(29.3.1980 to 3.5.1980)		(12.41980 to 30.5.1980)*	
Final				
Number of specimen	27	25	*	*
Size: Mean length (mm ± S.D)	58.18 ±5.33	50.56 ±5.40	79.25 ±9.79	64.06 ±6.36
Size: Mean weight (gm)	1.750	1.237	...	...
Differences (Final-Initial): Length (mm)	24.43	17.34	47.25	31.56
Differences (Final-Initial): Weight (gm)	1.464	0.957	...	...
Growth per day: Length (mm)	0.698	0.495	0.984	0.658
Growth per day: Weight (gm)	0.042	0.027	...	...

* On 30.5.1980 there was flood which affected the ponds and hence the experiment was terminated.

29.84‰ and 3.8 ml/l respectively and 33.7°C, 29.84‰ and 2.1 ml/l respectively at the bottom. The fluctuation in temperature in both the ponds was high at noon rising up to 36.0°C due to solar radiation.

Feed

A compounded feed was prepared using starch, fish meal, groundnut oil cake, wheat bran and starmin P.S. in the proportion 4:5:5:4:2 by weight and made into pellets and used for controls in the laboratory and in the field. The same feed prepared identically but with an addition of 10% w/v alcoholic extract of Alfalfa by volume in the proportion 4:5:5:4:2:7 was used for the experimental tanks in the laboratory and pond in the field. The triacontanol content of Alfalfa raw material from which the alcoholic extract was obtained was 0.998% by dry weight. The quantity of Alfalfa incorporated in the supplementary diet for prawns both in the laboratory tanks and in the culture ponds during the period of experiment are given in Table 1. The prawns in the laboratory and field (both control and experimental units) were fed with the respective compounded feed at a rate of 10% body weight.

Results and Conclusions

The details of experiments and the results obtained both in the laboratory and field are given in Table 2.

In the laboratory experiments it was found that the prawns in the experimental tank grew faster and has recorded an increase of 0.20 mm growth (0.02 gm) per day over the control kept in an identical situation and fed but without Alfalfa. In the field culture experiments an increase of 0.33 mm growth per day over the control was recorded.

The results indicate that Alfalfa increases the rate of growth in prawns. The optimum amount of Alfalfa to be applied for maximum growth based on the length and weight of experimental rearing animals has to be further studied.

NEW PENAEID PRAWN RESOURCES SHOWING UP ALONG MAHARASHTRA COAST*

Introduction

Introduction of mechanised trawling operations has been greatly beneficial to the maritime states of India and this has been found to be the case in Maharashtra state as well, since the fishermen has been able to fish beyond the traditional close inshore areas of the coast line and tap the fishery resources not exploited by the indigenous fishing operations. In several areas this has resulted in locating new fishing grounds and exploitation of unexploited resources of prawns and other groups, thereby increasing the production considerably over the years. The prawn fishery of Maharashtra state has been studied by Mohamed (1967, *Proc. Symp. Crustacea Mar. biol. Assoc. India* part IV: 1408–18) and others and they have enumerated the species of prawns contributing to the fishery. In recent times from 1977 onwards consequent to the increased operations of the trawlers especially in slightly deeper areas, some prawns which have not been earlier represented in this fishery are noticed to occur in increasing abundance in the landings at Sassoon Dock so as to contribute to substantial fishery. In view of the increasing demands for prawns, the details of the fishery and biological aspects of these prawns have been studied right from the initial occurrence of the species in the fishery and the results are presented here.

Species composition

The following four species of prawns belonging to the penaeidae were represented (Fig. 1–8).

Metapenaeopsis stridulans (Alcock): This is the 'fiddler shrimp' growing to a maximum total length of about 100 mm and can be easily identified by the presence of the stridulating organ (a row of small ridges) on the postero-lateral part of the carapace.

Parapenaeus longipes Alcock: Popularly known as the "flamingo shrimp", this is a still smaller species reaching a maximum total length of only 95 mm. The species is reported in fishable quantities for the first time and one of the important diagnostic feature is the presence of the longitudinal suture from the anterior to posterior margins of the carapace laterally.

Trachypenaeus curvirostris (Stimpson): This species known in popular English name 'southern rough shrimp' and locally 'Dugdu' grows to a maximum total length of 105 mm. The short and stumpy nature is characteristic of the species which is reported as a fishery in India for the first time.

Solenocera choprai Nataraj: FAO English name for the prawn is 'Ridgeback shrimp.' It reaches a maximum total length of 125 mm and the foliaceous antenna is the diagnostic generic character.

M. stridulans and *P. longipes* together constituted about 75% of the total landings of the four species at Sassoon Dock, the former contributing to 40% and the latter 35%. *S. choprai* formed 15% and *T. curvirostris* 9% on an average. *Atypopenaeus stenodactylus* and the crangonid shrimp *Pontocaris* sp. were found in stray numbers.

Fishing operations

The fishing was carried out by mostly country crafts operating 18–22 m shrimp trawls off Murud, Srivardhan and Harnai coasts of Maharashtra in a depth zone ranging from 40 to 75 m (Fig. 9). Gokhale (Science Today: 5–8, 1982) reported that fishermen of both Maharashtra and Gujarat fish in areas of this depth range using their small country crafts. Very recently the research vessel R. V. Saraswathi of Central Institute of Fisheries Education caught good numbers of some of the above mentioned species in a depth range of 60 to 70 m off Harnai coast (area 17–72.5 B) in trial fishing operations with a pelagic trawl, confirming the presence of these species in these depth areas.

Production

The combined total production of these four species put together at the centre was estimated at 11,720 tonnes during the years 1977 to 1983 with an average

* Prepared by M. Aravindakshan and J. P. Karbhari

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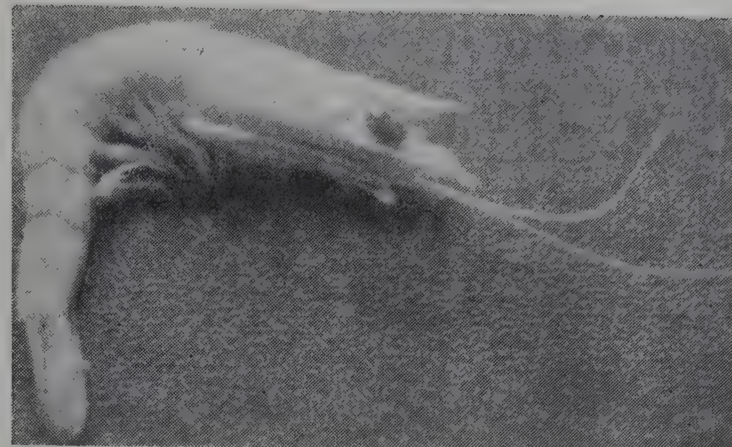 5

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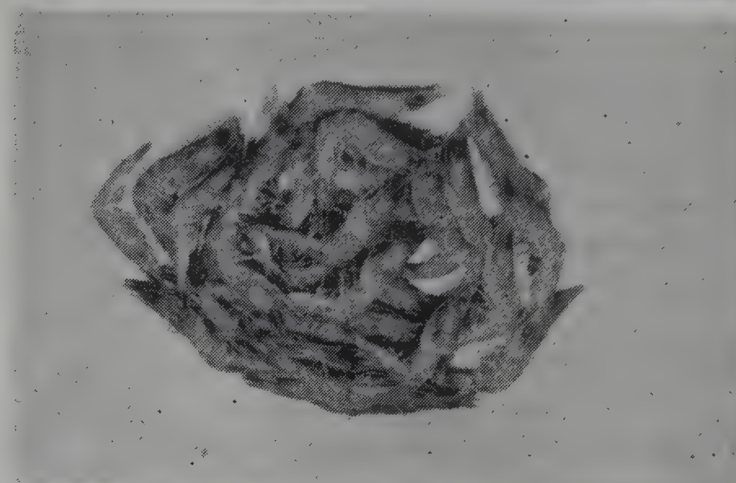 6

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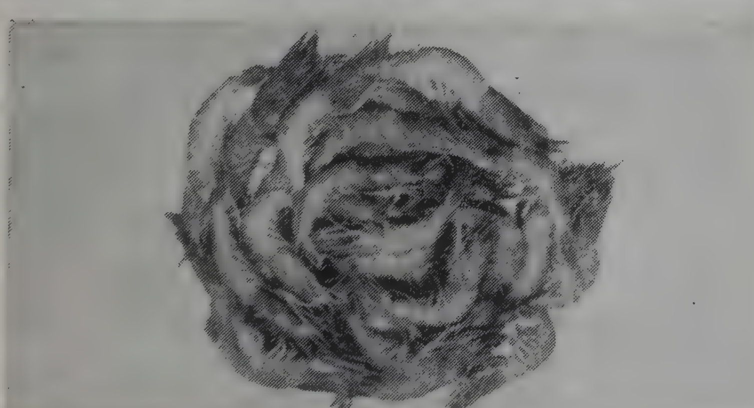
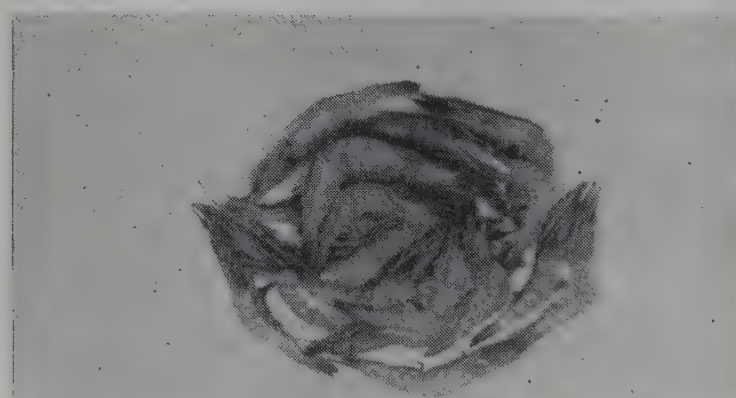
4 

 8

Figs. 1 & 2. *Solenocera choprai* Nataraj; 3 & 4. *Trachypenaeus curvirostris* (Stimpson); 5 & 6. *Metapenaeopsis stridulans* (Alcock); 7 & 8. *Parapenaeus longipes* Alcock.

yearly landing of 1,674 tonnes for each season. The magnitude of the landings of the constituent species during the different years is presented in Fig. 10. Taking the total production of the species, the landing figures were the highest during 1978 and 1979. Thereafter a slight decline was noticed in 1980 and 1981. However, in 1982 and 1983 the catches have gone up, although not reaching the 1978 and 1979 level. The average catch per unit amounted to 70 kg.

Fishing season

The fishery for these species is highly seasonal. The fishery commences from late February or early March and continues up to June, by the end of which month the trawler operations in deeper regions are suspended. The availability of large sized penaeid prawns in the shallower inshore areas in larger quantities and the onset of the monsoon are the factors leading to the suspension of fishing for these prawns.

Biological observations

Biological aspects like size ranges, sex ratio, maturity, food preferences etc. have been studied.

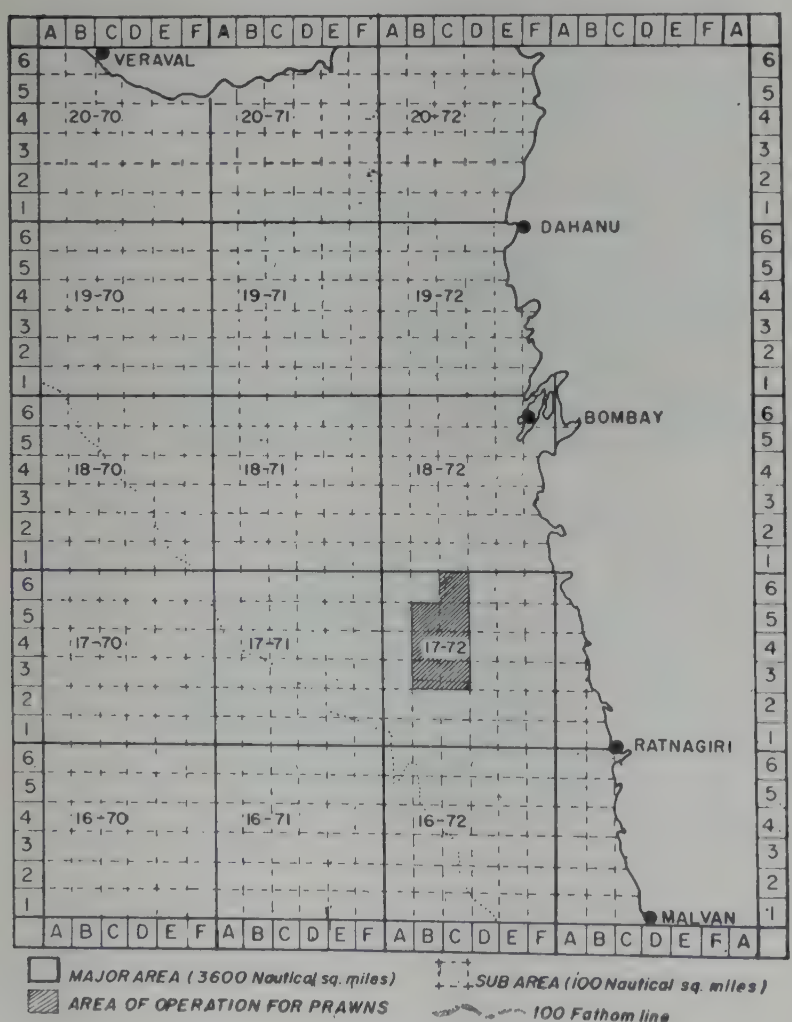


Fig. 9. Map showing the fishing area

M. stridulans was found to have a size range in the fishery between 55–85 mm. The sex ratio was 2:1 with females in domination. Analysis of the stomach contents of 1,125 specimens revealed appendages of decapod crustaceans, remains of gastropod molluscs followed by foraminifera, sand grains and debris. The

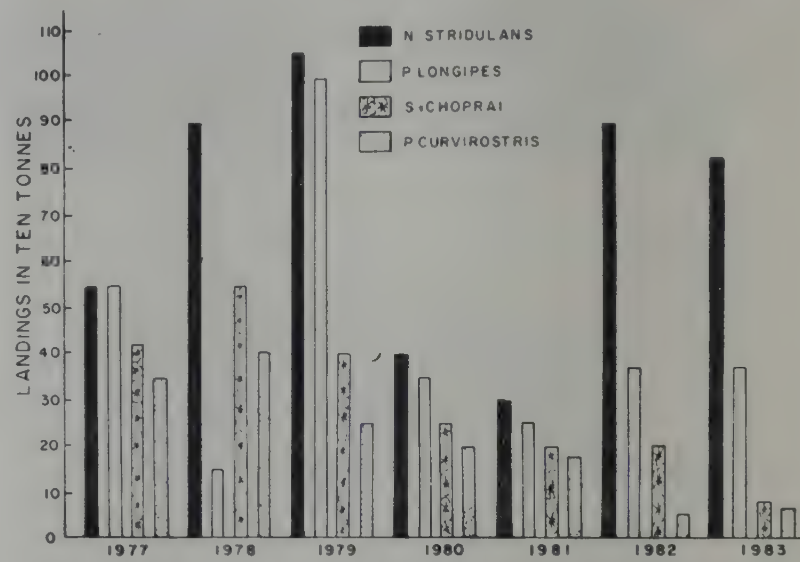


Fig. 10. Specieswise prawn landings during 1977-1983

major food items of crustacean remains formed 70%. The presence of sand grains and debris indicated a bottom feeding habit. Polychaete remains were not observed in the stomachs of the species. Percentage of mature females was observed to be maximum of 70% in March, indicating March–April as probable spawning months.

P. longipes ranged from 55–95 mm in length in the landings. In this species also females were always dominant (sex ratio 2:1) and larger in size. Stomach contents of 1,227 specimens showed that crustacean remains formed the major item of food, forming about 60% with molluscan remains and foraminifera constituting 18%. Sand grains and debris constituted remaining 22%. High percentage of mature females (80%) was observed in months of April and May, indicating spawning during these months.

S. choprai. The size range of the species noticed in the fishery was from 55–125 mm. Males were always smaller in size and less in numbers. Males exceeding 100 mm were not noticed and the sex ratio was 3:1 in general with females in domination. Study of stomach contents of 421 specimens showed a carnivorous diet with crustacean remains dominating (60%) mainly in the form of appendages of decapods.

Gastropod remains and foraminifera followed by sand grains and debris formed the remaining 40%.

Mature females occurred in larger numbers in March and April. During 1980 mature females were observed in August and September as well. The number of eggs in a fully mature female of 107 mm total length was estimated at 1,30,850. The high fecundity of the species points out to the possibility of existence of more exploitable stock in the case of this species.

T. curvirostris ranged from 60–105 mm in size in the fishery. The general sex ratio was 3:1 with females in domination. Males rarely exceeded 70 mm. Stomach analysis of 906 specimens showed items of food similar to the other three species, with crustacean appendages forming the major portion (70%). The percentage of mature females was observed to be 80 in April and May.

General remarks

Among the four species of these prawns it was noticed during the study that *M. stridulans* and *T. curvirostris* were hardy and lesss susceptible to decay than the other two species, *P. longipes* and *S. choprai* which developed blackening of appendages and gill region due to bacterial action much quicker. This would naturally affect the quality of the processed product and create problems for the processor. In order to keep the quality of the prawns proper preservation of the catches on board the vessels and small boats by carrying sufficient ice would be very essential.

The catches are being auctioned at the landing centre, the price varying from Rs. 10 to 15 per kg depending on the size and freshness of the prawns. At an average price of Rs. 12 per kg, prawns of these varieties at an estimated cost averaging 2 crores of rupees are being landed every season at this particular centre. As the price varies with the freshness of the prawns landed and the prawns being of the variety which develops blackenings quickly, no effort should be spared to see that the prawns are landed under proper preservation so that the fishermen could get the maximum price for his catch.

The authors are deeply grateful to Dr. E. G. Silas, Director, CMFRI for the interest and encouragement. They also express their sincere gratitude to Dr. M. J. George, Senior Scientist for scrutinising the manuscript and suggesting modifications. Thanks are also due to our colleague Shri S. K. Chakraborty.

GOOD SEASON FOR PRAWNS PREDICTED OFF MADRAS*

Forecasts of the magnitude of the prawn fishery based on the index of postlarval and juvenile abundance in estuaries and backwaters have been attempted by earlier authors. Garcia and Reste (1981 *FAO Fish. Tech. Rep.* 203:129) have summarised the forecasts based on earlier stages of life cycle. They have stated that "when an attempt is made to relate shrimp catches at the sea to the abundance of one of the preceding stages of the life cycle, it seems that only migrating subadults can give useful short-term prediction index (about three months in advance)" With the data available from the Ennore estuary near Madras on the postlarval and juvenile abundance an attempt was made to see whether any prediction of the forthcoming fishery of the ensuing season in 1983–84 was possible.

Regular weekly collections of juveniles were made with a small drag net made of velon screen of five m length at the Ennore estuary from three stations about 1 km apart from each other the first one being near the bar mouth. During the course of this study it was found that collections from Station III was good when compared to the other two stations as far as juvenile prawns are concerned and the data collected from this station for 19 months during March, 1982 to September '83 is analysed and interpreted in the present report. During day time three hauls were made roughly covering an area of 100 sq m. for each haul. The Ennore bar mouth is more or less kept open through out the year to draw coolant water for the thermal plant.

* Prepared by D. B. James and P. Thirumilu.

From Table 1 it is seen that during the period March, 1982 to September, 1983 maximum number of juveniles were collected during the months of July, 1983 (320 Nos) and August, '83 (342 nos.). During all other months on an average only 50 juveniles were collected. *Penaeus semisulcatus* started appearing by November to January period. The increased occurrence of the juveniles tend to show that the fishery for these species particularly *P. semisulcatus, P. indicus* and *P. monodon* will be high during the coming season from November to January period.

Table 1. *Numbers and sizes of juvenile prawns collected at Station III in Ennore estuary during* 1982–1983

Months	*Metapenaeus dobsoni*		*Metapenaeus monoceros*		*Penaeus indicus*		*Penaeus semisulcatus*		*Penaeus monodon*		Total
	No.	Size range mm	No.	Size range mm	No.	Size range mm	No.	Size range mm	No.	Size range mm	
1982											
March	2	7–18	5	12–24	1	15	1	37	—	—	9
April	1	13–22	5	13–22	1	24	—	—	—	—	7
May	10	9–21	5	11–34	1	15	—	—	—	—	16
June	9	5–16	1	24	1	13	1	17	—	—	12
July	6	7–17	19	7–20	—	—	—	—	—	—	25
August	2	9–13	42	7–25	—	—	1	17	—	—	45
September	64	7–21	10	7–28	—	—	1	15	—	—	75
October	24	7–16	14	7–15	—	—	—	—	—	—	38
November	47	8–22	1	11	—	—	—	—	4	18–30	52
December	90	7–18	12	7–19	—	—	—	—	—	—	102
1983											
January	62	8–16	2	9–12	—	—	—	—	—	—	64
February	29	8–25	15	11–36	—	—	—	—	—	—	44
March	26	8–18	7	8–46	—	—	1	35	—	—	34
April					No	collection					
May	23	7–24	6	7–28	—	—	19	11–62	—	—	48
June	7	10–21	9	13–39	—	—	12	11–44	—	—	28
July	274	8–20	7	11–24	27	13–26	12	13–62	—	—	320
August	119	9–13	15	16–54	90	14–52	97	16–56	21	14–64	342
September	154	7–34	12	9–52	10	15–22	5	11–52	1	16	182

during the month of May, 1983, *P. indicus* in July 1983 and *P. monodon* in August, 1983. When twigs were encountered in the drag net more juveniles of *P. monodon* were collected.

In Table 2 date-wise collections of juveniles from May 1983 when algal bed was formed is given. It is seen that the modal size increased in all species from May to September. Also it was found that the size range of the specimens collected was more in September than in May. This rapid growth in the estuary would result in the prawns reaching marketable size

The hydrological conditions of the estuary during 1982 and 1983 indicate that in 1983 the temperature has gone up to 37.2°C in May, 1983 whereas it was only 33.1°C in May, 1982. The four degree higher temperature may be the cause for the germination of the spores of the algae. The salinity was also found to be more in 1983 from May onwards.

It is interesting to note that the occurrence of the juveniles of some species especially *P. semisulcatus* show a relationship with formation of algal bed. In 1983 with the formation of algal bed composed of

Table 2. *Details of juvenile prawns collected per haul from Ennore estuary at Station III during May-September 1983*

Date	*Metapenaeus dobsoni*		*Penaeus semi-sulcatus*		*Metapenaeus monoceros*		*Penaeus indicus*		*Penaeus monodon*		Total
	No.	Size range mm	No.	Size range mm	No.	Size range mm	No.	Size range mm	No.	Size range mm	
4–5–83	2	11–24	10	11–62	2	14–28	—	—	—	—	14
18–5–83	18	7–20	3	11–17	2	7–15	—	—	—	—	23
26–5–83	8	9–17	13	11–32	4	13–28	—	—	—	—	25
29–5–83	2	13–17	37	14–57	22	13–56	2	32–76	1	27	64
1–6–83	5	10–17	2	13–44	7	11–27	—	—	—	—	14
8–6–83	3	16–21	3	17–44	5	13–21	—	—	—	—	11
15–6–83	—	—	6	11–42	2	15–32	—	—	—	—	8
22–6–83	3	8–20	5	18–42	1	39	—	—	—	—	9
6–7–83	3	9–16	1	13	1	15	—	—	—	—	5
20–7–83	180	8–20	8	15–62	4	11–24	28	13–26	—	—	221
24–7–83	48	6–22	128	15–84	4	13–32	20	17–37	—	—	199
31–7–83	73	7–22	58	15–52	19	17–41	28	10–42	4	11–24	189
3–8–83	74	20–27	20	16–56	6	16–54	20	14–41	6	14–30	126
7–8–83	38	8–24	32	15–69	38	11–80	16	15–56	5	16–41	129
10–8–83	15	9–30	16	15–60	—	—	32	16–52	9	14–63	72
21–8–83	8	12–29	32	15–81	13	16–90	14	16–90	2	9–24	69
24–8–83	29	12–32	44	15–94	6	16–60	45	15–52	6	17–40	130
28–8–83	4	16–22	32	19–68	9	14–46	4	16–38	1	25	50
31–8–83	40	12–31	49	14–93	8	13–57	24	13–72	7	14–62	128
4–9–83	11	16–41	5	32–100	9	16–67	2	27–72	—	—	27
7–9–83	10	11–34	2	11–43	3	15–51	3	15–22	—	—	18
14–9–83	8	7–23	2	19–52	4	9–52	4	15–22	2	16–39	20
25–9–83	14	7–14	4	24–71	4	22–62	19	15–44	—	—	41
28–9–83	135	7–29	—	—	5	11–32	4	17–44	—	—	144

species of *Hypnea, padina, Chaetomorpha* etc. there was sudden spurt of *P. semisulcatus* juveniles in the month of May. Again due to heavy rain in the month of August, 1983 most of the algae was found to be dead by 4–9–83. This immediately resulted in poor collection of juveniles particularly *P. semisulcatus* which always live in association with algae. In fact the juveniles of this species is locally known as *Pachi Yera* referring to this habit. The fact of absence of algal bed formation in 1982 when there was lesser juveniles also strengthen the point of view that there is correlation between algal bed and occurrence of these prawn species.

Compiled and prepared by M. J. George, G. Subbaraju, C. Suseelan and S. K. Dharmaraja
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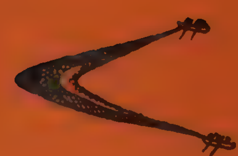

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THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the National Marine Living Resources Data Centre (NMLRDC) and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

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CONTENTS

Cover photo: New Ferry Wharf Jetty in Bombay.

INDEBTEDNESS AND UTILISATION OF FISHERIES CREDIT IN SAKTHIKULANGARA AND NEENDAKARA, KERALA — A CASE STUDY

R. Sathiadhas and G. Venkataraman

Majority of the fishermen of our coastal villages continue to be poor even though higher income has been generated among them by way of modernisation of fishing crafts and gears, mechanisation of indigenous boats and introduction of synthetic nets. The credit facilities that have been extended to them under the successive Five Year Plans steadily increased. However this has not resulted in any significant improvement in the standard of living of the majority of fishermen who continue to be in debt and in the grip of money lenders. In this context, it was felt desirable to carry out case studies regarding the state of indebtedness of fishermen and utilization of finance given to them in order to find out the maladies and suggest remedial measures in respect of credit facilities extended to them.

Sakthikulangara and Neendakara are two important fishing villages in Quilon district of Kerala state. Fishermen form majority of the population in these two villages where, in recent years, with the introduction of mechanised boats, there has been a great advance in the fisheries sector. This has led to the development of infrastructure facilities in this area like establishment of ice factories, cold storage plants and workshops for the repair of mechanised boats. The investment made here in this sector is far higher than in most of the other fishing centres and hence credit plays a vital role in their economy. Most of the fishermen in Sakthikulangara are engaged in mechanised fishing while in Neendakara it is otherwise, non-mechanised fishing being dominant. As the quantum of credit requirements and pattern of utilization differ between these two places, they were selected for the present studies. An account about the indebtedness of fishermen of this area during fifties and sixties was given by Asari T.R.T. and M.D. Menon in 1963. A detailed study of the socio-economic development that has taken place in this area is given in *Marine Fisheries Information Service No. 29, 1981* by Sathiadhas and Venkataraman. The present account dealing with the state of indebtedness is in continuation of the earlier studies carried out.

The objectives of this study are: (i) to find out the extent of indebtedness among the fishermen of Neendakara and Sakthikulangara (ii) to assess the role of Institutional and non-Institutional credit agencies in providing finance to the fishermen of this area and (iii) to examine the utilization of credit by fishermen of different income groups and compare the percentage contribution of their annual income towards payment of interest.

All the fishermen households of Neendakara and Sakthikulangara have been included in this investigation. A questionnaire was formulated to collect relevant information keeping in view the main objectives of this study. Before the actual data collection, pretesting of the questionnaire was done and it was suitably modified. Data were collected during March-May 1980 by visiting the houses and interviewing the heads of the families. The annual income mentioned in this study is the net income of the households from their respective occupations and other assets.

Extent of Indebtedness

Out of 429 families in Neendakara 263 (61 per cent) are in debt and out of 1,209 families in Sakthikulangara, 770 (64 per cent) are in debt. The total debt incurred by the fishermen families of Neendakara and Sakthikulangara worked out to 17.5 and 229.2 lakhs respectively. The average outstanding debt per indebted household in Neendakara and Sakthikulangara worked out to be Rs. 6,671 and Rs. 29,766 respectively.

Supply of Fisheries Finance

The availability of credit is an essential requirement to the people of this area engaged in fishing and fishery related activities for the purchase of mechanised and non-mechanised crafts, engines for boats, transport vehicles (ordinary as well as refrigerated/insulated vans), setting up of processing units of various types such as cold storages and ice plants, construction of godowns, peeling sheds, boat building yards and establishment of service and repair centres. The sources of finance are commercial banks, Kerala Financial Corporation, money lenders and co-operative societies. Of these, Kerala Financial Corporation and commercial banks play a leading role for the supply of credit in this area Money lenders also form an important source of credit for the fishermen. But the role of co-operative societies in extending credit to fishermen is quite limited. The details of extending credit by different agencies in the aggregate outstanding cash dues of fishermen at Neendakara and Sakthikulangara are given in Table 1.

Money lenders come foremost in respect of the quantum of credit supplied to the fishermen of Neendakara (46 per cent) while commercial banks stand first in this respect in Sakthikulangara (57 per cent). In Neendakara money lenders are followed by banks in respect of supply of credit with 31 per cent, Kerala Financial Corporation with 18 per cent, and the co-operative societies with 3 per cent. Regarding Sakthikulangara, next to banks, 28 per cent of credit is supplied by Kerala Financial Corporation and only 1 per cent by the co-operative societies. The contribution of others such as friends and relatives comes to 2 per cent in Neendakara and 1 per cent in Sakthikulangara.

Role of Credit Agencies

The supply of credit has two important though interdependent dimensions namely the cost or price of credit and the quantity or amount of supply at that price. To the weaker section of the society the credit market is also of dualistic structure composed of formal and informal markets. The fishermen, in many cases, find it difficult to obtain credit from the formal capital market as they are unable to fulfil the conditions imposed by it before extending credit facilities.

Table 2 indicated the extent of credit supplied by different agencies to fishermen households of various income groups at Neendakara and Sakthikulangara. Money lenders are the major source of finance to the lower income group (Rs. 2,500 and below per annum) in both the places, 61 to 72 per cent of the credit needs of this group being met by them. However it is seen that commercial banks have extended higher credit facilities to the fishermen of Sakthikulangara, 30 per cent and 26 per cent respectively when compared with that of the fishermen of Neendakara (4 per cent and 16 per cent respectively) of the lower income group (Fig. 1). In Neendakara the money lenders dominate even in the middle income groups (Rs. 2,500 - 10,000), whereas in Sakthikulangara substantial amount is advanced by the commercial banks to this category though the role played by money lenders is still significant. In Neendakara also the credit facilities extended by commercial banks to the fishermen belonging to middle income group is of a higher order (19 per cent and 37 per cent) compared to what has been observed in respect of lower income groups at this place. More than 87 per cent of the amount advanced by the commercial banks are for the purchase of mechanised boats, a loan of Rs. 90,000 being advanced for the purchase of a single boat. It may be seen that fishermen of Neendakara belonging to the higher income groups (Rs. 10,000 and above), whose number is very limited did not resort to money lenders for their credit needs as the same was met by the commercial banks (30 per cent) and Kerala Financial Corporation (70 per cent). However in Sakthikulangara, a good percentage of the credit is supplied by money lenders in addition to what has been obtained from banks and Kerala Financial Corporation. A significant feature noted is that the Kerala Financial Corporation supplied credit only to those who earn more than Rs. 5,000 per annum. This can be attributed to two factors, one being the fishermen having an income of Rs. 5,000 and above go in more for higher investments mostly for purchase of crafts and gears for which preference is given and the other being these fishermen are in a better position to fulfil the terms and conditions laid by the Kerala Financial Corporation.

The interest rate charged by money lenders in Needakara is in the range of 24 to 60 per cent and in Sakthikulangara 24 to 48 per cent. For more than 60 per cent of the loan advanced by money lenders, the interest charged is 36 per cent. The rate of interest charged by the commercial banks ranges from 11.5 per cent to 15 per cent. The rate of interest charged by the co-operative societies ranges from 12 per cent to 18 per cent and the Kerala Financial Corporation charges 11.5 per cent.

In addition to the professional money lenders, some boat owners also give loan to their crew apart from wages paid to them. Of the loan received by the lower income group from the money lenders as much as 80 per cent comes from boat owners and the rest from professional money lenders. The loan amount ranges from Rs. 1,000 to Rs. 3,000 depending upon the talent and experience of the workers and this is given on condition that he would work for him at least for an year. The boat owners used to charge interest of only 12 per cent for the loan and this lower rate of interest is compensated by paying comparatively lesser wages. The workers are bound to repay the whole loan with interest whenever they want to leave the concerned boat. In effect the majority of workers availing this facility are forced to continue their work under the same boat owner even if the working conditions are not satisfactory.

There are also some boat owners who took loans from the agents of processing plants on the condition that they would be giving prawns and other exportable items only to them. The agents recovered part of the loan when buying the catch at price fixed by them.

Demand for Credit

The utilization of credit for different purposes by the fishermen of Neendakara and Sakthikulangara is

given in Table 3. The loans taken for purchase and repairing of crafts and gears, purchase of land and gold ornaments, construction and maintenance of house buildings and working capital for business are considered for investment purposes. The amount taken for household expenditure during the lean season, expenditure on social and religious functions, medical treatment and for expenses on miscellaneous items are considered for consumption purposes.

It is observed that in Neendakara 62 per cent of the loan is utilised for investment as against 90 per cent in Sakthikulangara. In Sakthikulangara the bulk of the loan (79 per cent) is being utilised for the purchase of crafts and gears as against only 31 per cent in Neendakara. 18 per cent of the loans in Neendakara and 8 per cent in Sakthikulangara is used for the purchase of land and gold ornaments and construction and maintenance of house buildings. The amount taken for household expenditure during lean season is as high as 15 per cent in Neendakara as against only 1 per cent in Sakthikulangara. For social and religious functions 12 per cent and 7 per cent of the loan is utilised by the fishermen of former and latter respectively. While the people of Neendakara spent as much as 6 per cent of the loan towards medical expenditure, the people of Sakthikulangara only 1 per cent towards the same.

Consumption and Investment

Proportion of credit requirement for consumption and investment purposes by various income groups is given in Table 4. It is seen, in both the villages that lower the income, higher is the loan amount spent for consumption purposes and vice-versa. In Neendakara fishermen belonging to the lower income group (Rs. 2,500 and below) spent 9.5 per cent of the loans received towards investment purposes whereas in Sakthikulangara the same is 24 per cent. However in the middle income group (Rs. 2,500 - 10,000) the investment expenditure is more or less of the same order in both the places. In both the places in the higher income group (above Rs. 10,000) the diversion of credit towards consumption purposes is mainly towards social functions especially marriage.

Indebtedness, Income and Interest

The average debt, annual income and the amount to be paid as interest annually per household in different income groups are worked out and presented in Table 5 for Neendakara and Sakthikulangara.

It is seen that in both these places the average debt is more in the middle and higher income groups. This could be attributed to their going for higher investments in mechanised boats and for infrastructure facilities. The average debt in general, was found to be higher than their average annual income with a few exceptions for all the income groups.

A significant feature noted was that out of 166 families not in debt in Neendakara 31 per cent of them come from lower and 69 per cent from middle income groups. In Sakthikulangara out of 439 families not in debt 29 per cent come in lower, 69 per cent in middle and only 2 per cent in higher income groups. The lower and middle income groups are also paying greater interest rates than the higher income groups. The overall interest rates paid by the fishermen belonging to lower income groups are 24 and 26 per cent, middle income groups 20 and 18 per cent and higher income groups 12 and 14 per cent in Neendakara and Sakthikulangara respectively. The lower and middle income groups paying higher rate of interest due to their greater dependence on money lenders as compared to higher income groups who mostly depend on Institutional credit.

It is observed that 48 per cent of the annual income of a fishermen household of Sakthikulangara is spent for payment of interest while in Neendakara it is 41 per cent. The burden of debt falls more on the middle and lower income groups than on higher income groups. The fishermen of Sakthikulangara despite their higher level of earnings paid a greater percentage of their income towards interest as compared with those of Neendakara as the average indebtedness of the former is higher than that of the latter.

Conclusion

The average annual income of fishermen households in Neendakara worked out to Rs. 3,529 and Rs. 6,420 in Sakthikulangara. 61 per cent of the fishermen households in the former and 64 per cent of the latter are in debt. Total debt incurred by their families amounted to Rs. 17.5 lakhs in Neendakara and 229.2 lakhs in Sakthikulangara. The average outstanding debt per indebted household worked out to Rs. 6,420 in Neendakara and Rs. 29,766 in Sakthikulangara. 41 per cent of the annual income of the fishermen of Neendakara and 48 per cent of Sakthikulangara go for payment of interest for their loans.

Till recent past the fishermen of this area were almost entirely dependent on the money lenders for their credit requirements. Of late Institutional agencies have come into the picture and been advancing loans to the fishermen of this area. However they are able to

Table 1. *Loan advanced by different agencies*

	Amount advanced (Rs.)	
Source of credit	Neendakara	Sakthikulangara
Money lenders	8,00,150	65,27,550
Banks	5,46,600	1,30,55,330
Co-operative society	52,100	1,69,200
Kerala Financial Corporation	3,25,000	29,31,300
Others	30,600	2,36,600
Total	17,54,450	2,29,19,980

Table 4. *Proportion of utilization of credit for consumption and investment purposes by various income groups.*

	Neendakara		Sakthikulangara	
Income Group	Consum-ption	Invest-ment	Consum-ption	Invest-ment
1200 & Below	100	—	98	2
1201 - 2500	81	19	54	46
2501 - 5000	40	60	50	50
5001 - 10000	27	73	17	83
10001 - 20000	7	93	3	97
20001 - 30000	—	100	4	96
30001 - 50000	—	—	3	97
Above 50000	—	—	—	100

provide only 52 per cent of the credit needs of the fishermen of Neendakara and 68 per cent of Sakthikulangara. The rest of the credit needs are still met by the money lenders at higher rate of interest. This is specially seen in the case of fishermen belonging to the lower income groups. Hence Institutional agencies should play a greater role in meeting the credit requirements of the fishermen of this area with particular reference to the lower income groups. They are unable to avail the credit facilities from Institutional agencies to a greater extent as they are not in a position to fulfil the terms and conditions laid by them for extending loans. Some relaxation in the conditions should be thought of so that they can also avail the facilities to a higher extent.

Differences in the utilisation of loan amounts has been noticed between these two places. While as much as 90 per cent of the credit in Sakthikulangara goes for investment purposes, the same in the case of Neendakara comes to only 63 per cent. This is due to the diversion of more funds by the people of the latter towards consumption purposes. So there is need to motivate the people of Neendakara to go in more for investment purposes. In this regard extension workers have a greater role to play.

The establishment of a Fisheries Bank at Sakthikulangara just in the pattern of Rural Banks of Agricultural sector will go a long way to eliminate the money lenders and meet the credit requirements of the fishermen in this area. A Fishermen Co-operative Marketing Federation may be started here, which should not only help supplying materals for fishing activities but also help the fishermen in post harvest operations such as handling, processing, storage and marketing. The co-operative societies should be revitalised keeping in view the lower income groups who are the unfortunate prey of the money lenders, by supplying craft and gears to a group of 6 or 7 persons and the recovery be made through easy instalments.

Sakthikulangara is one of the biggest fish landing centres in India and the fishing activities will increase in this area with the coming up of Fisheries Harbour and the expansion of infrastructure facilities in the coming years. On account of these, the credit requirements of the fishermen of this area will increase. In this context, an integrated approach by the various Institutional agencies such as financial and welfare corporations of State, banks and co-operatives for supply of credit to fishermen of this area will go a long way in the growth of the fisheries sector.

The authors are thankful to Shri. T. Jacob, Scientist S-3 and Shri. K.K.P. Panikkar, Scientist S-1 for their valuable suggestions and comments.

Table 2. *Supply of credit by different agencies to fishermen of various income groups*

Income groups (Net income per annum in Rs.)	Supply of credit by different agencies (Rs.)											
	Money Lenders		Banks		Co-operative Society		Kerala Financial Corporation		Others		Total	
	N	S	N	S	N	S	N	S	N	S	N	S
1200 & below	4800 (61)	56250 (66)	300 (4)	26050 (30)	700 (9)	—	—	—	2050 (26)	3500 (4)	7850 (100)	85800 (100)
1201-2500	137050 (70)	230450 (72)	31250 (16)	84900 (26)	15050 (8)	1000 (—)	—	—	12400 (6)	6000 (2)	195750 (100)	322350 (100)
2501-5000	278600 (72)	958350 (54)	72400 (19)	792760 (44)	24650 (6)	11000 (1)	—	—	11750 (3)	9900 (1)	387400 (100)	1772010 (100)
5001-10000	379700 (45)	1951000 (35)	332650 (37)	2958600 (54)	11700 (2)	6200 (—)	125000 (15)	544300 (9)	4400 (1)	137200 (2)	853450 (100)	5597300 (100)
10001-20000	—	2222500 (26)	10000 (9)	5202120 (61)	—	151000 (2)	100000 (91)	849000 (10)	—	80000 (1)	110000 (100)	8504620 (100)
20001-30000	—	588000 (23)	100000 (50)	1576600 (60)	—	—	100000 (50)	442000 (17)	—	—	200000 (100)	2606600 (100)
30001-50000	—	421000 (14)	—	1614300 (53)	—	—	—	1011000 (33)	—	—		3046300 (100)
Above 50000	—	100000 (10)	—	800000 (81)	—	—	—	85000 (9)	—	—		985000 (100)

Note: 1. "N" denote Neendakara and "S" denote Sakthikulangara.

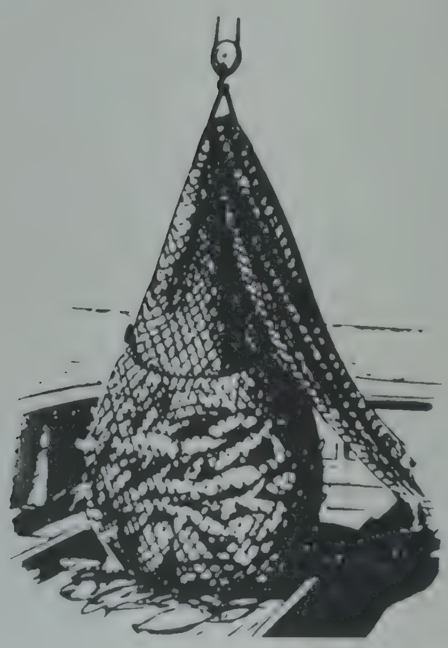
2. Figures in brackets indicate percentage of credit received by each income group in "N" and "S".

Table 3. *Percentage utilization of credit for different purposes*

Purpose	Percent utilization of loans	
	Neendakara	Sakthikulangara
I. INVESTMENT		
1) Purchase of crafts and gears	31	79
2) Repairing crafts and gears	6	1
3) Construction and maintenance of house buildings	11	6
4) Purchase of land and gold ornaments	7	2
5) Working capital for business	7	2
II. CONSUMPTION		
1) Household expenditure during lean season	15	1
2) Expenditure on social and religious functions	12	7
3) Medical expenditure	6	1
4) Miscellaneous	5	1

Table 5. *Details of household income, indebtedness and interest in Neendakara (N) and Sakthikulangara (S).*

Particulars		Income Group (Rs.)							
		1200 below	1201-2500	2501-5000	5001-10000	10001-20000	20001-30000	30001-50000	Above 50000
Total No. of households	N	12	128	205	80	2	2	—	—
	S	62	197	470	299	118	28	30	5
No. of households in debt	N	8	81	109	61	2	2	—	—
	S	34	97	264	202	112	27	29	5
Percentage households in debt	N	67	63	53	86	100	100	—	—
	S	55	49	56	67	95	96	97	100
Average debt of indebted households	N	981	2417	3554	24090	55000	100000	—	—
	S	2524	3323	6712	30755	75934	96541	101543	197000
Average annual income of the indebted household	N	1100	2000	3750	8000	15000	26000	—	—
	S	1150	22200	3800	8500	18570	28340	45300	135000
Annual interest to be paid	N	221	592	885	4700	6350	11750	—	—
	S	713	825	1458	5397	10632	14423	15044	27155
Percentage of interest to be paid from income	N	20	30	24	59	42	45	—	—
	S	62	38	38	63	57	51	33	20



BY-CATCH OF SHRIMP TRAWLERS IN GREATER BOMBAY*

Introduction

With the introduction of mechanized trawling operations, Maharashtra, with a coast line of 720 km, occupies an important place in the export oriented prawn fishing industry of India. The state stands second in penaeid prawn landings with an annual average (1971-80) of 27,000 tonnes, contributing to 25% of the all-India catch of penaeids.

Traditionally, the penaeid prawns have been caught by fixed bag nets "Dol". But during the last two decades, shrimp trawling has made rapid strides to contribute to bulk of its production. As in other areas, at Bombay also along with prawns large quantities of fishes both quality as well as cheaper fishes are landed as by-catch, a general report of which has appeared in these columns (Mar. Fish. Inf. Ser. T & E Ser. 28, 1981).

Sassoon Dock and New Ferry Wharf are two important bases in Greater Bombay for commercial trawling. The present account attempts to give a picture of the trawl fishery with special reference to prawns and by-catches during 1979-82.

The primary data were collected by the technical staff of the fishery resources assessment division. The manuscript was critically gone through by Dr. M.J. George. The authors record their thanks to them.

Craft and gear

Wooden boats of about 13.5 m in length with fish hold and fitted with 80 to 100 H.P. engines operate from these two bases. The number of boats operating from New Ferry Wharf is about 200-250, whereas from Sassoon Dock it is about 250 to 300. However, the duration of fishing operations differs. At Sassoon Dock, the absence from port is from 24 to 48 hours with actual fishing of 16 to 24 hours. At New Ferry Wharf, the absence lasts from 45 to 60 hours of which 32 to 36 hours are spent in actual fishing. Mostly boats belonging to Gujarat fishermen operate from the latter centre.

Fishing grounds extend from Ratnagiri in the South to Dahanu in North (17°-20°N and 72°-73°E). Some times the boats from New Ferry Wharf operate beyond Dahanu also. All the boats use 16 to 23 m otter trawl with head rope of varying length and cod end mesh of 25 mm.

Fishing season

At New Ferry Wharf the fishing season lasts from September to May. From June to August the fishing operations are suspended because of the rough sea conditions due to S.W.monsoon. At Sassoon Dock, the fishing season is identical but for the fact that during the monsoon period also some trawlers are operated in the nearshore waters.

Fishery

Total landings for both the centres varied from 38041.2 tonnes in 1979-80 to 42682.9 tonnes in 1981-82. The total landing for the entire period was 122921.7 tonnes (Table I) of which prawns constituted 31.3%. The by-catch contributed to the rest.

New Ferry Wharf

This centre accounted for 47.4% of the total landings. The catch varied from 17157.6 to 22751.7 tonnes during 1979-80 and 1980-81 respectively (Table I). The catch/fishing trip correspondingly ranged from 895.6 to 1128.5 kg during the same period. The prawn component was 33.1% (Table II).

Monthly variations in effort, catch and CPUE were observed during all the years (Fig. I). During 1979-80 the catches showed a fluctuating pattern with a pronounced peak in December. In the following year a steady increase in the catch was noticed upto December. The catch declined there after except for a secondary peak in April. During 1981-82 the fishery showed an upward trend upto January after which it gradually declined. The highest CPUE was seen coinciding with the maximum catch except during 1980-81 when the peak of CPUE occurred in November.

Sassoon Dock

This centre accounted for 52.6% of the total landing. The catch ranged from 19446.0 tonnes (CPUE 856.8 kg) during 1980-81 to 24326.5 tonnes (CPUE 1052.0 kg) during 1981-82 (Table I). Prawns constituted 29.6% on an average.

Month-wise, the catch revealed an upward trend till October. In the next year the catch showed wide fluctuations till March after which a gradual decline was observed. The best catch was in August. A secondary peak occurred in March and later in November. The following year also experienced wide variations in catch

* Prepared by Chakraborty S.K., Deshmukh V.D., Kuber Vidyasagar and Ramamurthy S. (in alphabetical order).

TABLE I

Catch in tonnes and cpue in kg.

	New Ferry Wharf			Sassoon Dock			Total		
Year	Effort (trips)	Catch	Catch/ Effort Kg.	Effort (trips)	Catch	Catch/ Effort Kg.	Effort (trips)	Catch	Catch/ Effort Kg.
1979-80	19159	17157.6	895.6	21572	20883.6	968.1	40731	38041.2	933.96
1980-81	20252	22751.7	1128.5	22697	19445.9	856.8	42949	42197.6	982.5
1981-82	19398	18356.4	946.3	23106	24326.5	1052.8	42504	42682.9	1004.21
Total	58809	58265.7	990.78	67375	64656.0	959.6	126184	122921.7	974.15
Average	19603	19421.9	990.7	22458	21552.0	959.6	42061	40973.9	974.15

TABLE II

Year-wise catch composition of different categories of fishes and their percentages in parenthesis at New Ferry Wharf

	1979-80	1980-81	1981-82	Average	Rank
Elasmobranch	1747.95 (10.19)	1014.22 (4.46)	971.32 (5.30)	1244.50 (6.41)	6
Eels	186.41 (1.09)	362.11 (1.60)	2086.93 (11.37)	878.48 (4.52)	7
Cat fishes	1198.08 (6.98)	499.81 (2.20)	851.65 (4.64)	849.85 (4.38)	8
Nemipterus	623.43 (3.63)	319.6 (1.40)	411.23 (2.24)	451.42 (2.32)	10
Sciaenids	2930.45 (17.08)	3167.74 (13.92)	2339.12 (12.74)	2812.44 (14.48)	2
Ribbon Fishes	1651.62 (9.63)	1984.85 (8.72)	1712.89 (9.33)	1783.12 (9.18)	4
Quality Fishes	1839.44 (10.72)	963.48 (4.24)	940.5 (10.57)	1581.14 (8.14)	5
Prawns	5327.21 (31.05)	8801.13 (38.68)	5175.88 (28.2)	6434.74 (33.13)	1
Other Crustaceans	251.95 (1.47)	291.59 (1.28)	229.32 (1.25)	257.62 (1.33)	11
Cephalopods	849.16 (4.95)	493.43 (2.17)	698.27 (3.80)	680.29 (3.50)	9
Miscellaneous	551.87 (3.21)	4853.77 (21.33)	1939.27 (10.56)	2448.30 (12.61)	3
TOTAL	17157.57 (100.00)	22751.73 (100.00)	18356.38 (100.00)	19421.90 (100.00)	

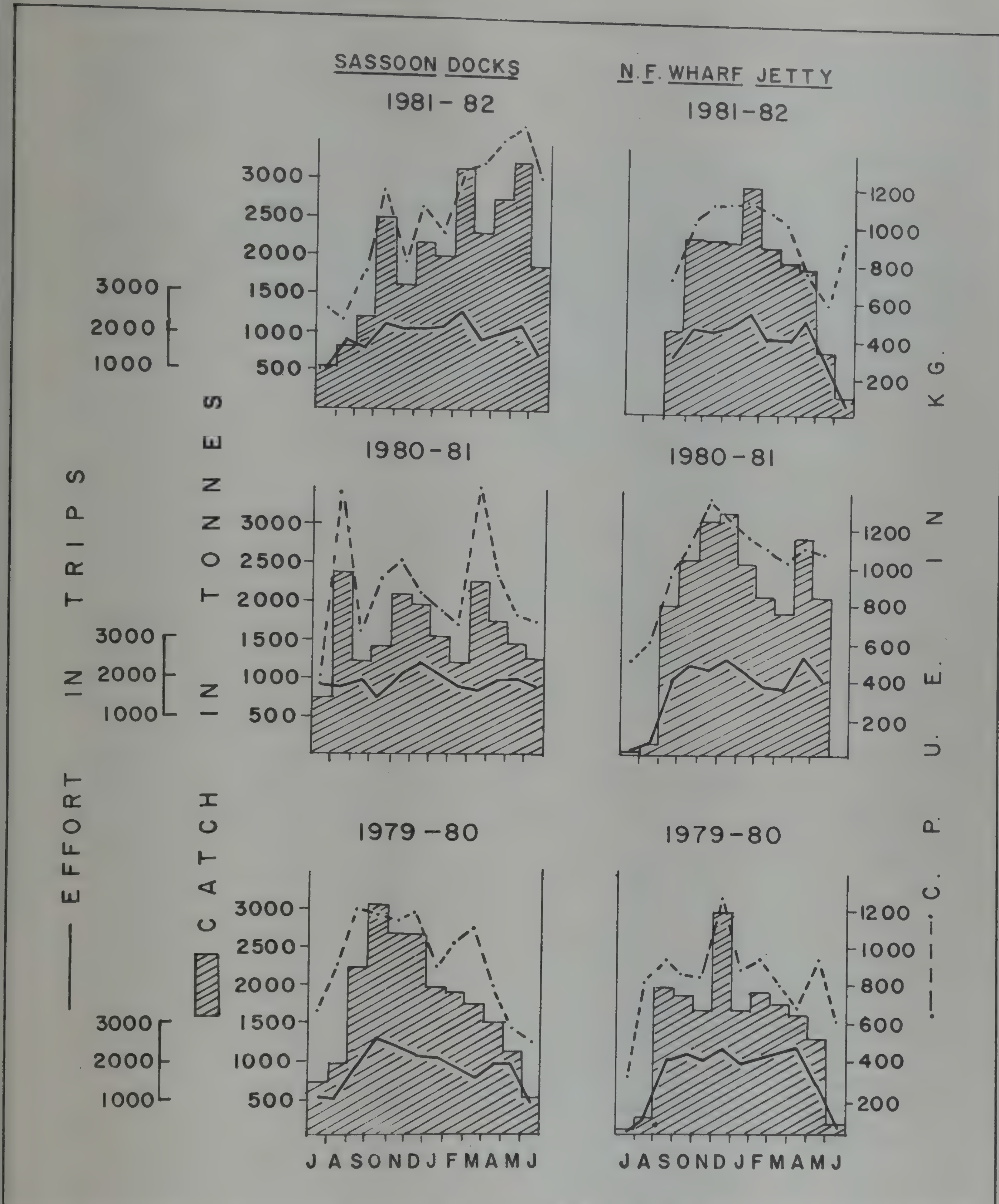


Fig. 1. Seasonal variations of catch, effort and C.P.U.E. at New Ferry Wharf and Sassoon Dock.

with three periods of abundance in October, February and May in the increasing order. The CPUE also showed more or less similar fluctuations with the peak occuring mostly during March and May (Fig. 1).

Catch composition

The catch has been grouped into prawns and the rest as by-catches consisting of fishes, cephalopods and other crustaceans (Plate I). The estimated catch of the various groups and their percentage composition at the two centres is given in Table II and III to show thier annual variations.

By-catch

Fishes contributed to 62% and 64.5% respectively at New Ferry Wharf and Sassoon Dock. These are represented by a number of groups of species whose month-wise and species-wise fluctuations are given in Fig. 2 and 3.

Elasmobranchs: Although occurring throughout the year, they were most abundant during October to January. During March and April also they were common in the catches. Exceptionally high catch of 809 tonnes was netted in March 81 from Sassoon Dock

TABLE III

Year-wise catch composition of different categories of fishes and their percentages in parenthesis at Sassoon Dock

	1979-80	1980-81	1981-82	Average	Rank
Elasmobranch	1309.52 (6.32)	2113.30 (10.86)	1164.53 (4.78)	1529.11 (7.09)	7
Eels	140.17 (0:67)	72.49 (0.37)	107.59 (0.44)	106.75 (0.49)	11
Cat fishes	1865.42 (8.93)	1478.86 (7.60)	2633.71 (10.82)	1992.66 (9.24)	3
Nemipterus	1744.16 (8.35)	700.16 (3.6)	2501.52 (10.28)	1648.62 (7.64)	5
Sciaenids	3611.21 (17.29)	4894.35 (25.16)	3352.00 (13.77)	3952.52 (18.33)	2
Ribbon Fishes	1540.23 (7.37)	1430.05 (7.35)	1983.03 (8.20)	1651.10 (7.66)	4
Quality Fishes	2052.80 (9.82)	587.88 (3.02)	2178.37 (8.95)	1606.35 (7.45)	6
Prawns	6642.32 (31.8)	6127.47 (31.51)	6359.25 (26.14)	6376.34 (29.58)	1
Other Crustaceans	150.03 (0.71)	91.52 (0.47)	197.16 (0.81)	146.23 (0.67)	10
Gephalopods	983.07 (4.70)	483.61 (2.48)	1882.76 (7.73)	1116.48 (5.18)	9
Miscellaneous	844.84 (4.04)	1466.21 (7.53)	1966.55 (8.08)	1425.86 (6.61)	8
TOTAL	20883.17 (100.00)	19445.93 (100.00)	24326.47 (100.00)	21552 (100	

comprising of 34.6% of the total catch. The elasmobranchs ranked sixth and seventh in abundance at New Ferry Wharf and Sassoon Dock respectively.

Eels: This group is represented by a single species *Muraenasox telabonoides* locally known as "Wam" and is caught only seasonally. At Sassoon Dock the fishery generally commences from November and continues upto June, whereas the seasonal abundance at New Ferry Wharf was very erratic. At Sassoon Dock, they were abundant in January, December and March-April respectively whereas at New Ferry Wharf the abundance was in May, March-April and January respectively during 1979-80,'80-81 and '81-82. The eels were relatively more abundant at New Ferry Wharf with an annual average catch of 878.5 tonnes (4.5%). The fishery was exceptionally good at this centre during 1981-82.

Cat Fish: These ranked third in abundance contributing on an average of 9.2% of the catch at Sassoon Dock. At New Ferry Wharf they were far less abundant (4.4%). The fishery, mainly constituted by *Arius dussumieri, A. sona* and *Osteogeneosis militarias* was at the peak generally during September-January. However, during 1981-82 it was observed during February-May.

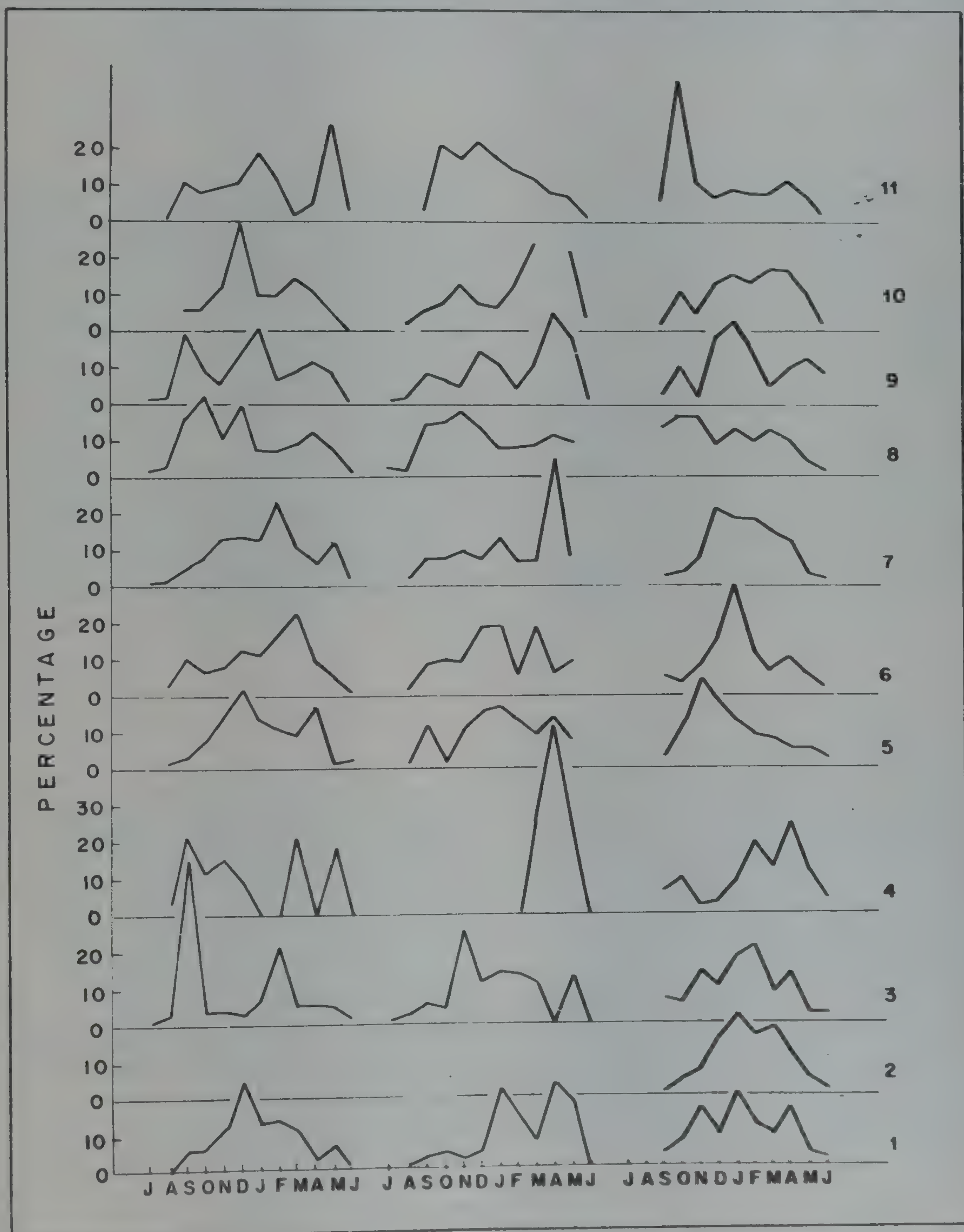


Fig. 2. Distribution pattern of major catagories in the shrimp trawl at New Ferry Wharf.
1. Elasmobranch 2. Eels 3. Cat fish 4. Nemipterus 5. Sciaenids 6. Ribbon fish 7. Quality fish 8. Prawns 9. Other crustaceans 10. Cephalopods 11. Miscellaneous

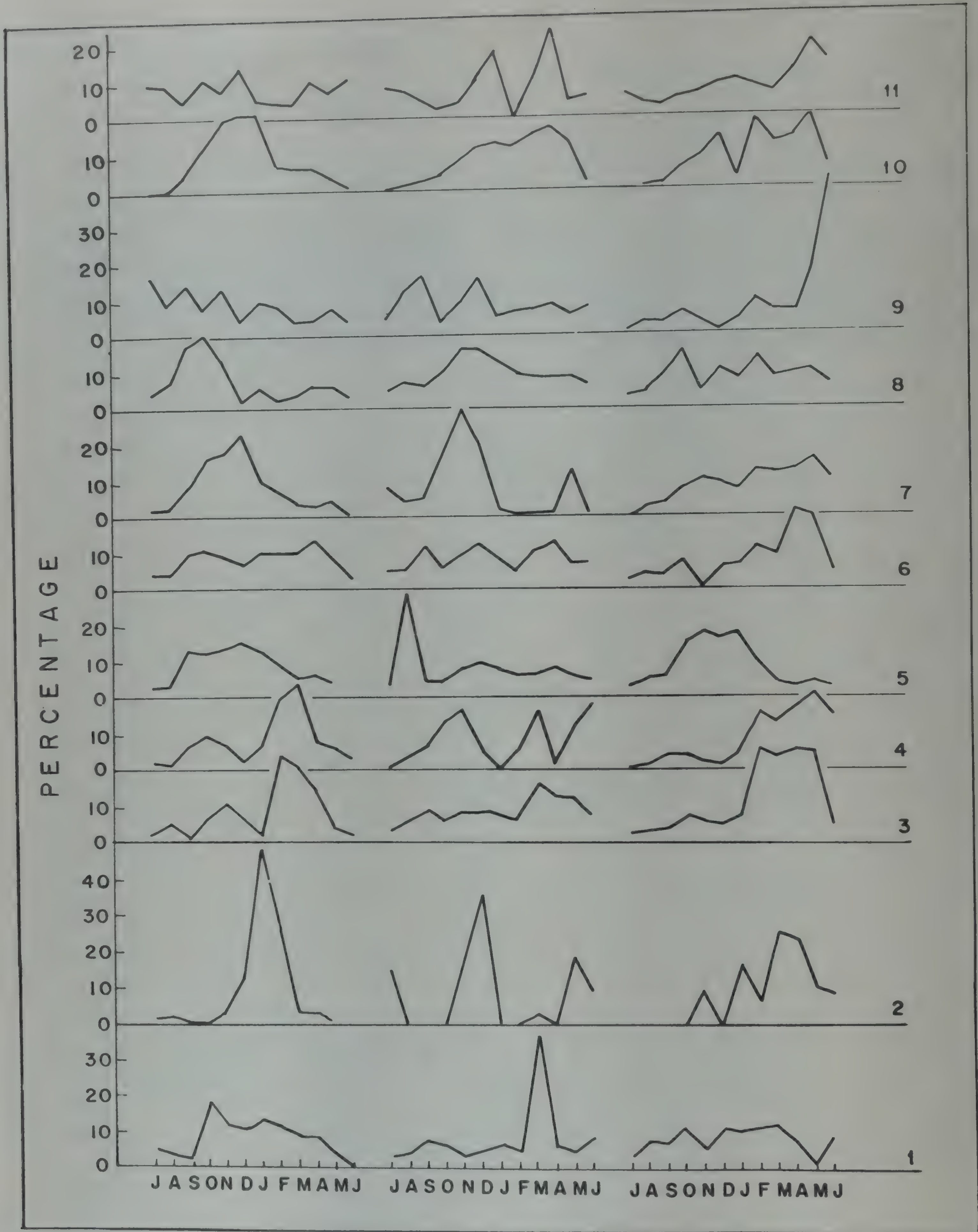
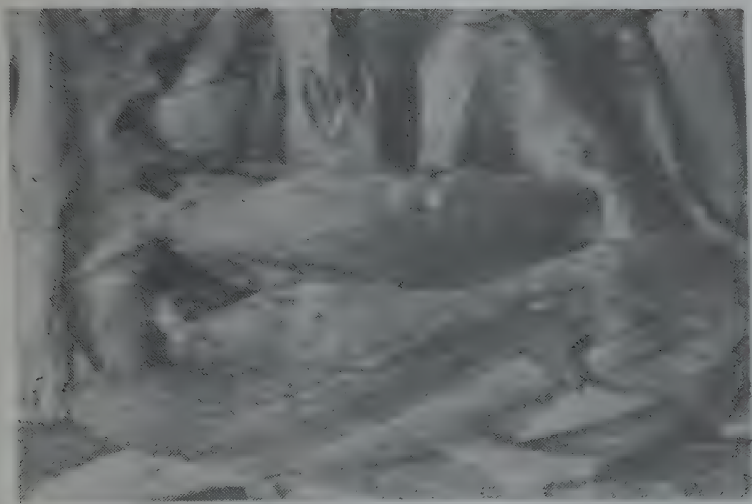
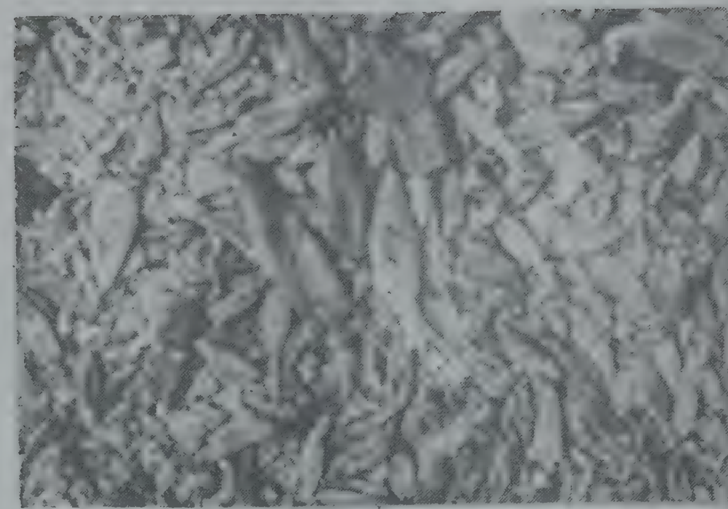


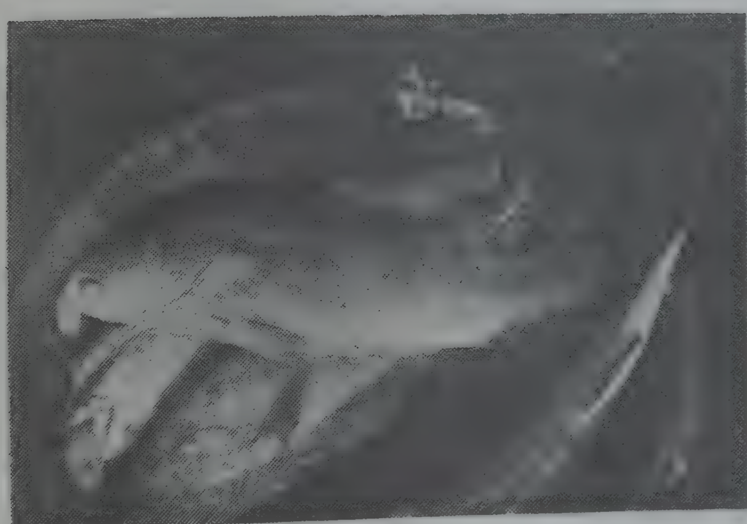
Fig. 3. Distribution pattern of major catagories in the shrimp trawl at Sasson Dock.
1. Elasmobranch 2. Eels 3. Cat fish 4. Nemipterus 5. Sciaenids 6. Ribbon fish
7. Quality fish 8. Prawns 9. Other crustacean's 10. Cephalopods 11. Miscellaneous.



Catfish

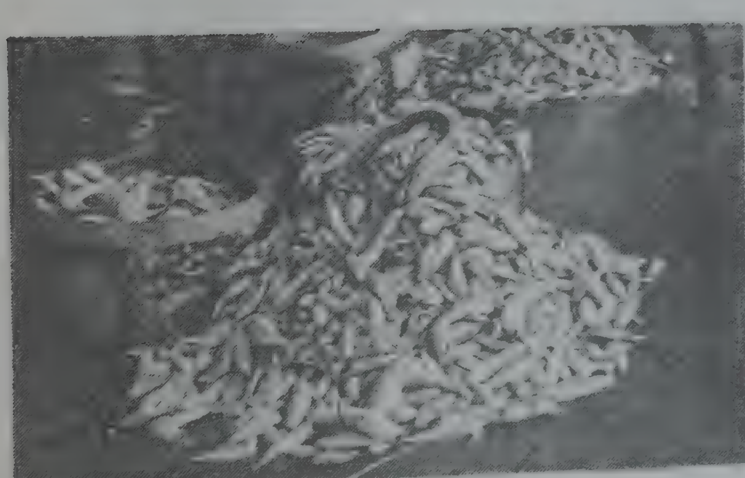


Cephalopods

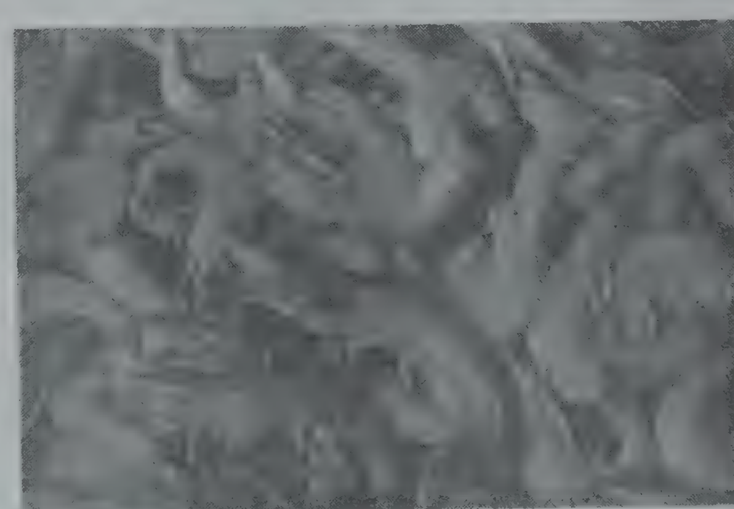


Nibea diacanthus

Lobster



Sciaenids



Prawns

Nemipterus: Locally known as 'Rani' three species viz. *Nemipterus japonicus, N. mesoprian* and *N. delogoae* occur in the catch, of which the first one is the most abundant. Ranked as fifth in abundance at Sassoon Dock, the average annual catch was estimated to be 1648.6 tonnes forming 7.6%. At New Ferry Wharf the fishery accounted only for 451.4 tonnes forming 2.3%. Generally there appeared to be two periods of abundance, February-May and September-November the former being the maximum.

Sciaenids: Of all the by-catch components, sciaenids are the most abundant group occurring at both the centres almost throughout the year. Locally, known as 'Dhoma', it includes smaller sciaenids. Species in order of abundance are *Johnius macrorhynus, Johniops vogleri, Otolithus cuvieri, O.ruber* and *Johniops dussumieri.* Average annual catch of this group at New Ferry Wharf and Sassoon Dock was 2812.4 and 3952.0 tonnes forming 14.5% and 18.3% respectively of the total catch. Their abundance at New Ferry Wharf was noticed in December and April, September and January and November and at Sassoon Dock in September and December, August and October-January during 1979-80, 1980-81 and 1981-82 respectively at the two centres.

Ribbon Fish: Locally known as 'Wakti' they are represented by *Trichiurus lepturus* and *T. savala* in the trawl catches regularly. They ranked fourth in abundance at both the centres with mean annual catch of 1783.1 and 1651.1 tonnes at New Ferry Wharf and Sassoon Dock respectively. Bulk of the catch was obtained during January-April.

Quality Fishes: These include pomfrets, carangids, perches, clupeids, polynemids and *Nibea diacanthus* etc. which, though individually contributed to a small fishery, but as a group occupied fifth place in abundance at New Ferry Wharf (1581.1 tonnes and 8.1%) and sixth place at Sassoon Dock (1606.4 tonnes and 7.5%). Clupeids contributed to 4.7% and 3% at Sassoon Dock and New Ferry Wharf respectively. The other major component among the quality fish was *Nibea diacanthus* (10.6%) at New Ferry Wharf.

Prawns: These form the largest component at both the centres. The mean annual catch was 6434.7 and 6376.3 tonnes with 33.2% and 29.6% of the catch at New Ferry Wharf and Sassoon Dock respectively. The fishery had a peak during October/November and a secondary peak during March/April (Fig. 2 and 3).

Penaeids contributed to the bulk of prawn landings. They were represented mainly by *Parapenaeopis stylifera, Solenocera spp., Metapenaeus affinis* and *M. monoceros.* Other species of minor importance were M. brevicornis, Metapenaeopsis stridulans, P. sculptilis and *Penaeus spp.* Non-penaeids were represented by *Nematopalaemon tenuipes* and *Acetes indicus.* The specise-wise fluctuations of the shrimp catch is given in Fig. 4.

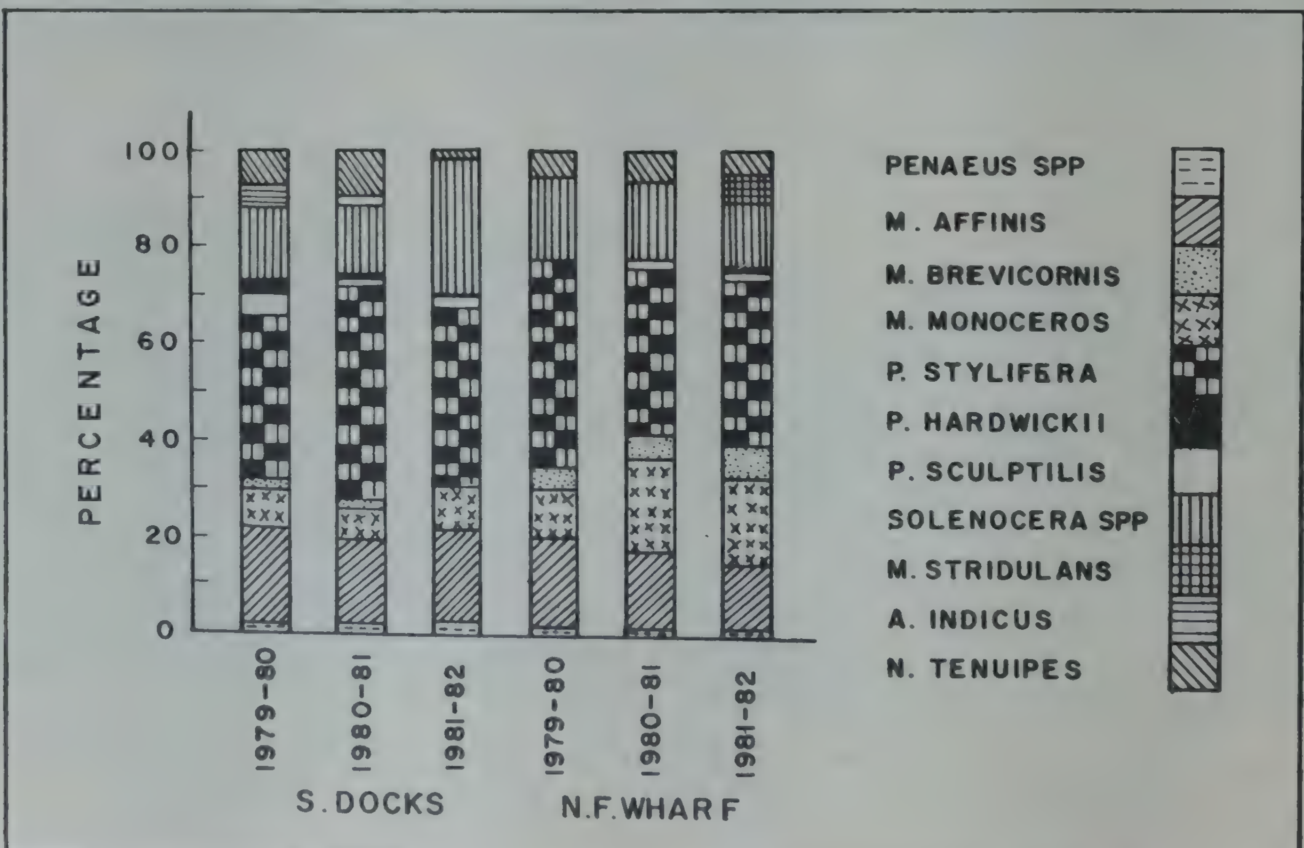


Fig. 4. Annual fluctuations of the species in the shrimp catch.

Other Crustaceans: An average of 257.6 and 146.2 tonnes were landed at New Ferry Wharf and Sasson Dock respectively, represented by lobsters mainly *Panilurus polyphagus* and *Thenus orientalis* and crabs in negligible quantities. Lobsters were more common during Septmber-December, January and April-May at New Ferry Wharf.

Cephalopods: Locally known as 'Makul', they occurred throughout the year in the trawl catches except during the monsoon months. Represented by squids, *Loligo duvauceli* and cuttle fish *Sepia aculeata* and *S. pharaonis*, they formed 3.5% and 5.2% of the catch at New Ferry Wharf and Sassoon Dock respectively. Good catches of cuttle fishes were observed from October to December and of squids from January to April.

Miscellaneous: Several other species of fishes such as Bombay duck, *Saurida sp.* seer fish, Tunnies, flat fishes Upeneus spp. etc. collectively accounted for 2448.3 tonnes contributing to 12.6% of the catch at New Ferry Wharf. At Sassoon Dock, miscellaneous fishes formed 1425.86 tonnes amounting to 6.6 per cent.

Marketing and disposal

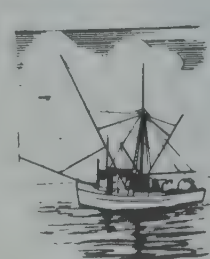
Because of the availability of fish hold facilities on the trawlers and cleaner wharf at the landing site, the catch is landed in fairly good condition. The catches are auctioned daily at the landing centre itself. For this reason there is no consistency in the price structure. From the fishermen the catch goes to the middlemen who purchase the fish in auction. From there on, it is sorted out both size and quality wise and handed over to processors. This is done mainly in the case of items with export value like prawns, lobsters, cephalopods and quality fishes. Because of the middle men the fishermen get less profit out of the catch. Rest of the fish is transported to various markets for local consumption. Thus most of the by-catch is utilized for human consumption as observed by George *et al* *(Mar. Fish. Infor. Ser. T & E Ser. No. 28, 1981)*, nothing from the trawler catches is wasted. The estimated annual value of the catch at the auction site of both the centres was Rs. 404 million. Of this the prawns accounted for about 42%, lobsters 14%, quality fishes 19% and cephalopods 3%.

Remarks

The present study revealed that the fishing effort over the three years remained more or less steady at both the centres. This is a good sign as there is no increase of fishing pressure on the stocks. The fishery at Sassoon Dock registered an upward trend whereas at New Ferry Wharf, it showed fluctuating trends with 1980-81 recording the maximum catch. Most of the species constituents had the peak during October-April, following the south-west monsoon period. Compared to New Ferry Wharf, Sassoon dock was a better landing centre from the point of view of total catch. However, the catch per fishing trip was more at the former because the boats from this centre expended more hours of fishing coupled with wider operational range of fishing grounds. Eels, lobsters and miscellaneous fishes comprising of flat fish, tunnies etc. registered significantly higher catch at New Ferry Wharf showing that the grounds fished by these trawlers supported a comparatively rich fishery for these varieties.

Though this study did not indicate any adverse trend in the fishery, continued monitoring of the resources is necessary for scientific management of the fishery.

Further, it could be inferred that though the cheaper fishes formed the bulk of the by-catch, it contributed to only 22% of the annual value. These varieties are consumed either fresh or dried in domestic markets. Thus the fishermen's income is largely dependent on crustaceans, cephalopods and quality fish for export. It would therefore be advisable to go in for better product development out of the cheaper varieties to ensure better utilization in internal markets which would ultimately benefit the primary producers of the sea in getting better returns from the catches.



A POTENTIAL NEW RESOURCE OF PRAWN FROM THE KARNATAKA COAST*

Introduction

Along the Karnataka coast, Mangalore, Malpe and Karwar are centres from where prawns are caught in fairly good quantities throughout the year. The prawn production in Karnataka is mainly through mechanised sector, the contribution by non-mechanised sector being quite negligible. It is estimated that around 4 to 5 thousand tonnes of prawns are landed in this state annually and the important species contributing to the fishery are *Metapenaeus dobsoni, M. affinis, M. monoceros, Parapenaeopsis stylifera, Penaeus indicus, P. merguiensis* and *P. monodon* belonging to the penaeid group.

Artisanal estuarine fishery for prawns at Mangalore

The non-mechanised gears like shore seine, miniotter trawl and cast net are operated throughout the year in the estuaries, and during monsoon period (June-August) in the inshore waters, for catching prawns. However, the prawn production from the estuarine waters is rather low in this area. It is estimated that at Mangalore only 5.3 and 14.4 t of prawns were landed from this sector during 1981 and 1982 respectively, contributed mostly by *M. dobsoni* and *P. indicus*. It is interesting to note that in addition to these, another species was landed in appreciable quantities, in these years and found to support a minor fishery in the Mangalore estuary for the first time. This species was subsequently identified as *Metapenaeus moyebi (= Metapenaeus burkenroadi)*. Out of the total prawn catch from this estuary, this species alone accounted for 30.2% and 15.0% with the catch amounting to 1.59 t and 2.16 t respectively during 1981 and 1982 (Table 1). Although the species was available from May to December, the peak catches were obtained during May-July. Among the gears, miniotter trawl was the most effective, contributing 66.1% and 59.7% of the total catch of this prawn, followed by shore seine (29.5% and 21.1%) during 1981 and 1982 respectively. *M. moyebi* formed around 32.8% and 13.4% in miniotter trawl, 66.5% and 21.0% in shore seine and 5.1% and 16.3% in cast net, respectively during these periods (Table 1). Other than a few stray specimens collected from the trawl catches during May-June, this species was not caught in appreciable quantities from the inshore waters of Mangalore.

Fishery at Karwar

An entirely different picture is seen at Karwar, *M. moyebi* being caught exclusively from the inshore waters during these periods. Shore seine is generally operated in the Karwar Bay during monsoon period (Fig. 1). In June 1980 in addition to *P. indicus* and *M. dobsoni*, *M. moybi* (Fig. 2) occurred in sizeable quantities in these shore seine catches. The occurrence of this species has not been recorded from this area earlier and it is reported for the first time. Surprisingly, again this species was caught in large quantities (2.1 tonnes) by shrimp trawlers from the Karwar Bay during May 1981. (The shrimp trawlers, usually, do not operate in Karwar Bay. However, some boats operated in the Bay between 25.5.1981 and 29.5.1981 on their way back from the usual fishing grounds). The prawn catch mainly consisted of *M. dobsoni, M. affinis, M. moyebi* and*P. merguiensis*. The data on *M. moyebi* landed by trawlers during the above period was collected, mainly through enquiry, as the catches from the Bay and the usual trawling grounds were put together and brought to the shore. Further observations revealed the occurrence of this species in January and February, May and July and November and December in the prawn catches from Karwar Bay.

Size composition of M. moyebi

In the case of this species the sizes ranging from 31 to 90 mm in males and from 31 to 95 mm in females supported the estuarine fishery at Mangalore.
The stray specimens collected from the trawlers at Mangalore were of larger sizes (100-106 mm). The inshore fishery at Karwar Bay was supported by larger sizes ranging from 46 to 100 mm and 46 to 110 mm in males and females respectively.

Maturity and sex ratio

Majority of females were found to mature at 68 mm size. In the Mangalore estuary, practically all prawns were immature except in May 1981 when around 15.2% of females in a sample was found to be mature. A few specimens collected from the trawl catches at Mangalore during May-June were fully mature. At Karwar, mature females were recorded during January-February and May-July with maximum in June 83 (Table 2). It appears that the peak spawning in this prawn is during January-February and May-June. Month-wise distribution of sex ratio indicated that the proportion of females ranged from 56.0 to 88.0% at Mangalore and 30.6 to 83.0% at Karwar (Table 3). The overall ratio for males and females was 30.6 : 69.4 and 40.3 : 59.7 at these centres.

* Prepared by K.K. Sukumaran and G. Nandakumar with the guidance of Dr. M.J. George.

Table 1. The estimated catch and c.p.u.e. in kg and percentage composition of *M.moyebi* in different gears at Mangalore and Karwar

	MANGALORE						KARWAR					
	Miniotter trawl			***Cast net***			***Shore seine***			***Shore seine & trawl***		
Month	catch	% in prawns	catch/ unit	catch	% in prawns	catch/ unit	catch	% in prawns	catch/ unit	catch	% in prawns	catch/ unit
June 1980	—	—	—	—	—	—	—	—	—	156.0	20.5	0.7
May 1981	600.0	84.1	2.0	—	—	—	—	—	—	2,128.0	1.9	6.5
June	200.0	25.8	0.6	70.0	37.8	0.1	370.0	80.4	2.8	252.0	49.9	0.8
July	125.0	58.8	0.4	—	—	—	87.5	100.0	1.3	—	—	—
August	7.5	50.0	—	—	—	—	12.0	53.3	0.3	—	—	—
September	80.0	44.4	0.4	—	—	—	—	—	—	—	—	—
November	37.5	6.0	0.2	—	—	—	—	—	—	—	—	—
December	3.0	27.3	0.1	—	—	—	—	—	—	—	—	—
May 1982	15.0	16.7	—	15.0	8.3	—	—	—	—	—	—	—
June	1110.0	21.3	0.7	398.0	17.0	0.4	443.0	24.2	1.7	393.0	28.1	2.2
July	103.0	40.7	0.1	—	—	—	—	—	—	—	—	—
November	64.0	2.2	0.2	—	—	—	15.0	4.2	0.5	—	—	—
January 1983	80.0	23.2	0.2	—	—	—	—	—	—	—	—	—
February	—	—	—	—	—	—	—	—	—	12.0	26.7	—
June	312.0	33.7	0.3	—	—	—	—	—	—	112.0	28.4	0.6
July	—	—	—	—	—	—	—	—	—	7.0	1.2	—

Fig. 1. Shore seine operations in Karwar Bay

Fig. 2. *M. moyrbi* caught from Karwar Bay

Table 2. Percentage distribution of mature and spent/spent recovering females of *M. moyebi* during different months at Mangalore and Karwar.

	June 1980	May 1981	June 1982	Jan. & Feb. 1983	June	July
MANGALORE						
M	—	15.2	—	—	—	—
Sp/SpR	—	—	—	—	—	—
KARWAR						
M	7.4	1.0	5.2	23.5	32.6	6.8
Sp/SpR	—	—	50.6	36.5	30.4	—

M - mature; Sp/SpR - Spent/spent recovering

Table 3. Sex ratio distribution of *M.moyebi* during different months at Mangalore and Karwar (% of females)

	June 1980	May 1981	June	July	August	Nov.	June 1982	July	Jan. & Feb. '83	March	June	July
MANGALORE	—	64.8	56.1	60.0	63.5	73.2	88.0	70.0	—	75.5	73.8	—
KARWAR	54.6	76.6	—	—	—	—	40.9	—	30.6	—	72.3	83.0

General remarks

M. moyebi is found to support a minor fishery in the Mangalore estuary as well as in the Karwar Bay. The estuarine fishery at Mangalore is largely supported by smaller sizes, whereas, at Karwar the inshore fishery is supported by larger sized prawns. The interesting point about the fishery of this species here is that although juveniles are abundant in the Mangalore estuary, apart from a few stray specimens caught in the trawl nets, adults are not caught in appreciable quantities either from the estuary or from the nearby inshore area. With the result the location of the adult population remains unknown and if it is possible to locate this population anywhere nearby it would definitely increase the catches of larger sized prawns.

At the same time in Karwar the adults are caught in fairly good quantities from the inshore waters of the Bay, while juveniles are not caught from any of the nearby estuaries. Thus in this case it is not clear where exactly the juvenile phase of this adult population is completed. From the occurrence of a few juveniles (26-32 mm) from the same area in the Bay in June (in 'gorubale' catch) the possibility of their entire life cycle being completed in the Bay itself cannot be ruled out. Or it is also possible that this adult population of this particular species is originated from the stock found in the Mandovi-Zuari estuarine system of the Goa coast where the species in smaller sizes are found to occur during the monsoon period.

It is equally intriguing that the adult population of this species is caught from the Karwar Bay in fairly good quantities only during a very limited period of May-July. The search for this unconventional resource in the nearby areas during the rest of the year as well as other localities has not been successful so far. Thus it is not clear what happens to the stock of the population during the rest of the year. It is possible that the resource of the species is limited so as to be fished out during the period of 2 or 3 months. But in that case the smaller size groups of the prawns also should have been represented in the catches at some time or other. Experimental trawling at different depths along this coast particularly during March-May would probably throw more light on this problem.

PROVEN TECHNOLOGY
7. TECHNOLOGY OF CULTURED SEAWEED PRODUCTION

Major highlights

Production of seaweeds by culture practices is done generally by vegetative propagation of small fragments of some agarophytes, alginophytes and carrageenophytes. The fragments of the seaweed to be grown are inserted into the twists of the coir ropes or in the alternative tied to the mesh intersections of the HDP ropes (3 mm thick) which are fabricated in the form of 5 x 2 m size nets and floated at subsurface level in the inshore waters or in saline ponds with the help of sinkers and buoys. *Gracilaria edulis* and *Gelidiella acerosa* reach harvestable size after 2 and 2½ months respectively when the seaweed is harvested and processed for agar extraction.

Operational details

The seaweed culture farm either in the sea or in saline ponds will have several nets of 5 x 2 m size fabricated with coir (2.5 cm thickness) or HDP ropes (3 mm thickness). In the case of ponds, they should be preferably of sandy-loam bottom and of size 60 m x 30 m with free flow of seawater through sluice gate. The culture site must have a minimum depth of 1 m. The seed material is generally collected from natural beds and cleaned thoroughly to get rid of the debris, sand and other epiphytic algae. The length of the seed material is 4 to 5 cm for *Gracilaria edulis* and *Gelidiella acerosa*. The seed fragments are inserted into the twists of the coir rope but if it is a HDP rope net, the fragments of *G.edulis* and *G.acerosa* are tied to the mesh intersections of the nets with the help of nylon twine (No. 6). Fragments of *G.acerosa* are also tied to the nails fixed on the coral stones with the help of nylon twine (No. 6) and introduced in the inshore waters or in ponds. To minimise sedimentation on the plants, the stones are kept in cages. The minimum period for the seed material to reach harvestable size is 2 months for *G.edulis* and 2½ months for *G.acerosa*. Again the nets are reintroduced into the ponds or into the inshore waters with fresh seed material. Likewise six crops could be harvested in a year for *G.edulis* and 4 harvests for *G.acerosa* in a place like Mandapam where Gulf of Mannar or Palk Bay could be made use of for culture operations in a year alternating each other. The weight obtained after harvest is generally 3 times the initial weight. In the case of cultivation in inshore waters the crop is exposed to certain hazards such as grazing by fish and sedimentation. These problems can be minimised by carrying out culture operations in 4 to 5 m deep areas using floats and sinkers. Periodical cleaning of the nets is very essential to remove sediments and attached organisms.

Production

One kg seed material of *G.edulis* yields an average of 3 kg per sq.m of net after 60 days growth. In one ha area of nets (i.e. 1000 nets) 30 tonnes of fresh *G.edulis* could be obtained in one harvest. Six harvests could be made in a year if the condition of the sea is favourable. The nets could be used for several crops. *G.acerosa* cultured on nets in the inshore waters yields three fold increase in weight after 2½ months growth. In the case of cultivation on coral stones, three fold increase in the yield would be obtained after 5 months.

Inventory of materials

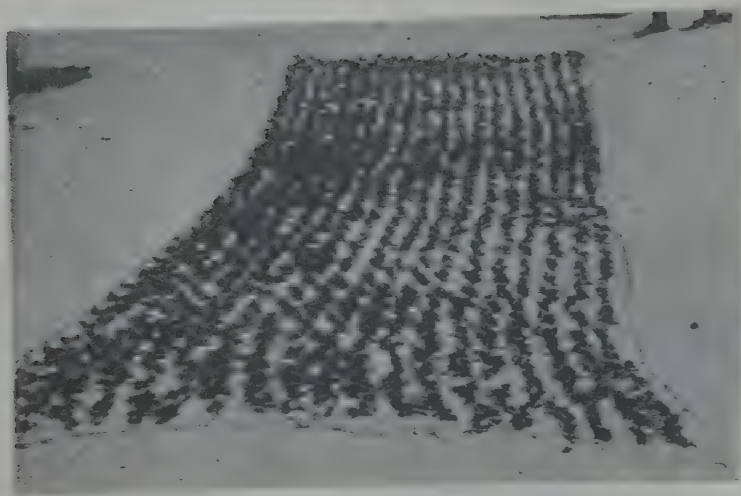
Cost of production of *G. edulis* only has been worked out so far and discussed here. For the cultivation of *G. edulis* in one ha, 1000 coir nets of 5 x 2 m size, 2000 casuarina poles of 1.5 m height and 10,000 kg of fresh seed material (for initial introduction) are required. The cost of 2000 casuarina poles is Rs. 6,000/- and cost of 1000 coir rope nets is Rs. 33,000/- including charges for fabrication. The seed material will be collected for the initial introduction from the natural beds and from the cultured crop for the subsequent seeding. Wages for seeding, harvesting and maintenance of the seaweed farm for 4 persons at the rate of Rs. 10/- per day for 360 days workout to Rs. 14,400/-. The total expenditure for one year would be Rs. 54,000/- including miscellaneous expenditure of Rs. 600/-.

Estimated cost of production

The estimated cost is arrived at on the assumption that a minimum of four harvests could be made in a year. A total of 120 tonnes (fresh weight) of crop could be obtained from the four harvests in a year when the yield is 3 kg/m^2. If the seaweed is dried (75% moisture) and marketed at a rate of Rs. 2,000/- per tonne, the net profit would be Rs. 6,000/- for one year.

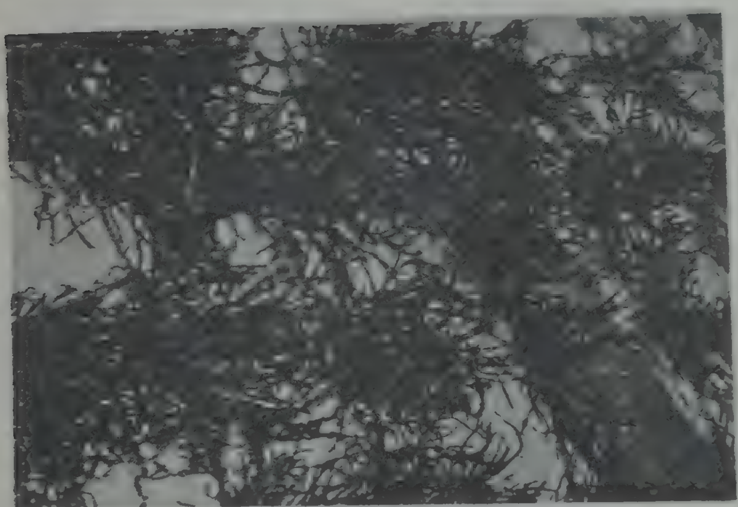
Prospects

India has a good scope for starting a seaweed culture industry based on the know-how available at the Central Marine Fisheries Research Institute. Potential areas for seaweed culture would be the coastal areas of Palk Bay and Gulf of Manner near

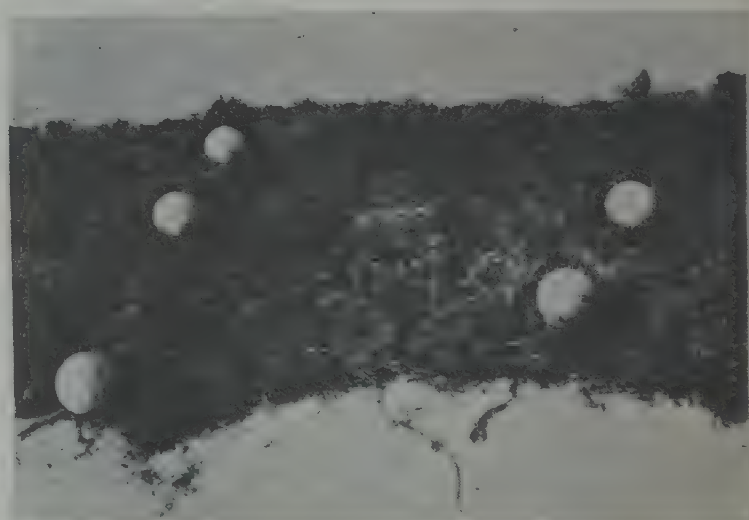


G. edulis
Culture net with seed material

G. edulis
Portion of the culture net showing the introduced seed material



G. edulis
Culture net showing 30 days growth



G. edulis
Culture net after 60 days growth

Mandapam and near the islands of Gulf of Mannar. Many industries producing agar and algin are being set up in India and the commercial harvest of seaweeds have gained importance in the coastal areas of Ramanathapuram, Tirunelveli and Kanyakumari districts of Tamil Nadu. Culture of seaweeds on large scale would be of great help to augment the supply of seaweeds in addition to that harvested from the natural beds. The Central Marine Fisheries Research Institute can extend the technical know-how through training programmes at managerial and operative levels.

Prepared by the scientists of seaweed culture project

NEWS — INDIA AND OVERSEAS

New resources of fishes located in Indian coastal waters

In recent surveys made by the Fishery Survey of India (FSI) under the Indian Ministry of Agriculture large stocks of marine fishes and other resources have been reported to have been located in the coastal waters in different areas. Among the varieties identified are bulls eyes, pomfrets, mackerel, shrimps, squids, perches and sharks.

Bulls eyes have been reported in good quantities between 11° and 20° N latitudes at depths between 40 to 200 m along the east coast. Pomfrets were found in quantity at depths of 60 to 90 m off Machilipatnam and mackerel off Visakhapatnam on the east coast. Deep sea shrimps occurred at depths of more than 190 m along the lower east coast as well as 200 to 500 m depths off Goa, Karwar and Ratnagiri. Squids were located in plenty at around 300 m depth off Andhra Pradesh coast. Perches and sharks have been fished in large quantities in the Wadge Bank area.

Record quantities of shrimp expected by farming in Equador

Shrimp ponds in Equador are expected to produce 50,000 tonnes by 1986. The combined trawling and pond culture production of shrimp in the country stood at less than 18,000 tonnes two years ago. Heavy rains this year have assisted shrimp culture by ensuring plentiful supply of seeds for pond stocking.

The industry will have more than 12,500 acres of shrimp ponds in use within the next three years according to officials of the country's fast growing aquaculture industry. In order to help in this expansion work, Taiwanese technicians have been brought to the country and shrimp pond operations are carried out under their advise.

FNI 22(7), July 1983

First International Conference on the Culture of penaeid prawns/shrimps

First announcement of the first International Conference on the Culture of penaeid prawns/shrimps scheduled to be conducted at Iloilo City, Philippines from December 4 to 8, 1984 under the auspices of Aquaculture Department, Southeast Asian Fisheries Development Center (SEAFDEC) has been issued. Papers for presentation at the Conference are invited on the following areas of penaeid prawn/shrimp biology and culture:

(1) Biology (2) Broodstock and gonadal maturation (3) Larval and postlarval rearing (Hatchery/nursery techniques) (4) Grow-out in ponds/tanks/cages/pens (5) Natural food (6) Nutrition and feed development (7) Physiology (8) Diseases (9) Socio-economics and marketing.

Abstracts of papers should reach the secretariet by July 15, 1984 and full papers by October 15, 1984. Registration fee is US $150. For further details please contact the Secretariet, First International Conference on the culture of penaeid prawns/shrimps, SEAFDEC Aquaculture Department, P.O. Box 256, Iloilo City, Philippines.

Compiled and prepared by M. J. George, G. Subbaraju & S. K. Dharmaraja
Published by Dr. M. J. George, Senior Scientist on behalf of the Director, Central Marine Fisheries Research Institute, Cochin-682 018 and printed at PAICO, Cochin-31

MARINE FISHERIES INFORMATION SERVICE

No. 55

JANUARY, 1984

Technical and Extension Series

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

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THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the National Marine Living Resources Data Centre (NMLRDC) and the Research Divisions of the Institute, results of proven researches for transfer cf technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

Abbreviation - *Mar. Fish. Infor. Ser. T & E Ser.,* No. 55: 1984

CONTENTS

Cover photo: Little tunas landed at the Fisheries Harbour, Cochin by the drift gill nets.

FOCUS ON SMALL SCALE FISHERIES: DRIFT GILLNET FISHERY OFF COCHIN, 1981 AND 1982

E. G. Silas, P. Parameswaran Pillai, A. A. Jayaprakash and M. Ayyappan Pillai

Introduction

The main emphasis in the marine fisheries development programme during the first three Five Year Plan periods and the following three Annual Plans was on the mechanisation of fishing crafts existing at that period and introduction of new mechanised fishing boats. With the advent of mechanisation in the fishery sector, development of diversified fishing methods in the artisanal fishery has gathered momentum. In recent years, the drift gillnet fishery has become one of the fast growing fishing methods in the coastal fishing sector because of its economic viability and selectivity for catching larger pelagics which find ready acceptance and consumer demand in the market. However, experience has shown that the fishermen engaged in this fishery by and large are not benefitted fully commensurate with the effort expended by them, mainly because of their financial constraints to acquire, own and operate the mechanised boats, and their dependence on 'middle men' for disposal of the catch. The present report embodies the result of the study carried out on the mechanised drift gillnet fishery off Cochin and the cost-benefits of the operation during the period 1981 and 1982.

The mechanised drift gillnet fishery, commenced in the inshore waters of Cochin in 1969, and in 1977 about 90 small mechanised *(pablo type)* boats were in operation using nylon drift gillnets, with base at Fort Cochin. The Cochin Fisheries Harbour, constructed at a cost of Rs. 4.0 crores and controlled by the Cochin Port Trust was commissioned in 1978. About 130 drift gillnetters were registered in 1979 in the harbour where facilities for handling, packing and transport of the catch are available. The berthing charges levied by the Harbour authorities for gillnet boats with catch till 1981 was Rs. 3 per day which was enhanced to Rs. 4 in 1982. Similarly, from 1982, charges for utilizing space for net repairs for gillnets at the rate of Rs. 5 per day was also introduced. Fishermen from Kanyakumari District constituted ninetyfive percent of the personnel engaged in the operation of the drift gillnets off Cochin. The agents, merchants and the labourers attached to them manage the disposal and marketing of the fishes landed at the Fisheries Harbour.

Fishing area

The area of operation of the drift gillnetters is generally in the 20–50 m depth zone off Cochin (Fig. 1). As the drift gillnet operations are confined to the surface and mid-depth zones at the fishing grounds, a brief review of the hydrographic features of the area during 1981 and 1982 is presented here *(C. P. Ramamritham,* Personal communication).

The overall intensity of upwelling during 1981 was less than that in 1980. During the monsoon season of 1981, a noticeable intermittent upwelling occurred during August in the inshore area off Cochin. By late October, the monsoon features disappeared and during November more or less uniform temperature conditions prevailed from surface to bottom. By December, there was an overall increase in temperature and salinity with inversion of the upper layers.

Summer of 1982 was associated with a noticeable decrease in the dissolved oxygen content in the whole vertical column of water. The summer temperature values in the region were of the order of 30–32°C. During the monsoon of 1982, the peak upwelling was noticed during mid-July. At the 20 m depth zone, thermocline could be observed at 5m depth with a temperature record of 22.5°C at 10m level. By mid-August, the inshore belt of this area was occupied by a single cold water mass of temperature between 23.0 and 24.5°C. During monsoon, the surface dilution was drastic and the surface bottom difference in the salinity was nearly 10‰. The changeover from monsoon was observed during September to October period. The waters have become warmer with a noticeable increase in dissolved oxygen content, and by December end a more or less isothermal water column was established in this area with oxygen values of nearly 80% of the saturation values at the said temperature and salinity.

Material and Methods

Weekly four trips amounting to 16 days in a month were made to the Fisheries Harbour, Cochin for the field sampling programme during 1981 and 1982 to estimate the daily, monthly and year-wise catch and effort. Regular catch and effort data were maintained by monitoring the catch and species composition by random sampling. To estimate the monthly species-wise composition and catch, the average weight of catch per unit on observation days was multiplied by the number of units in operation on that day and the total for all observation days was raised to the total number of actual fishing days in that particular month.

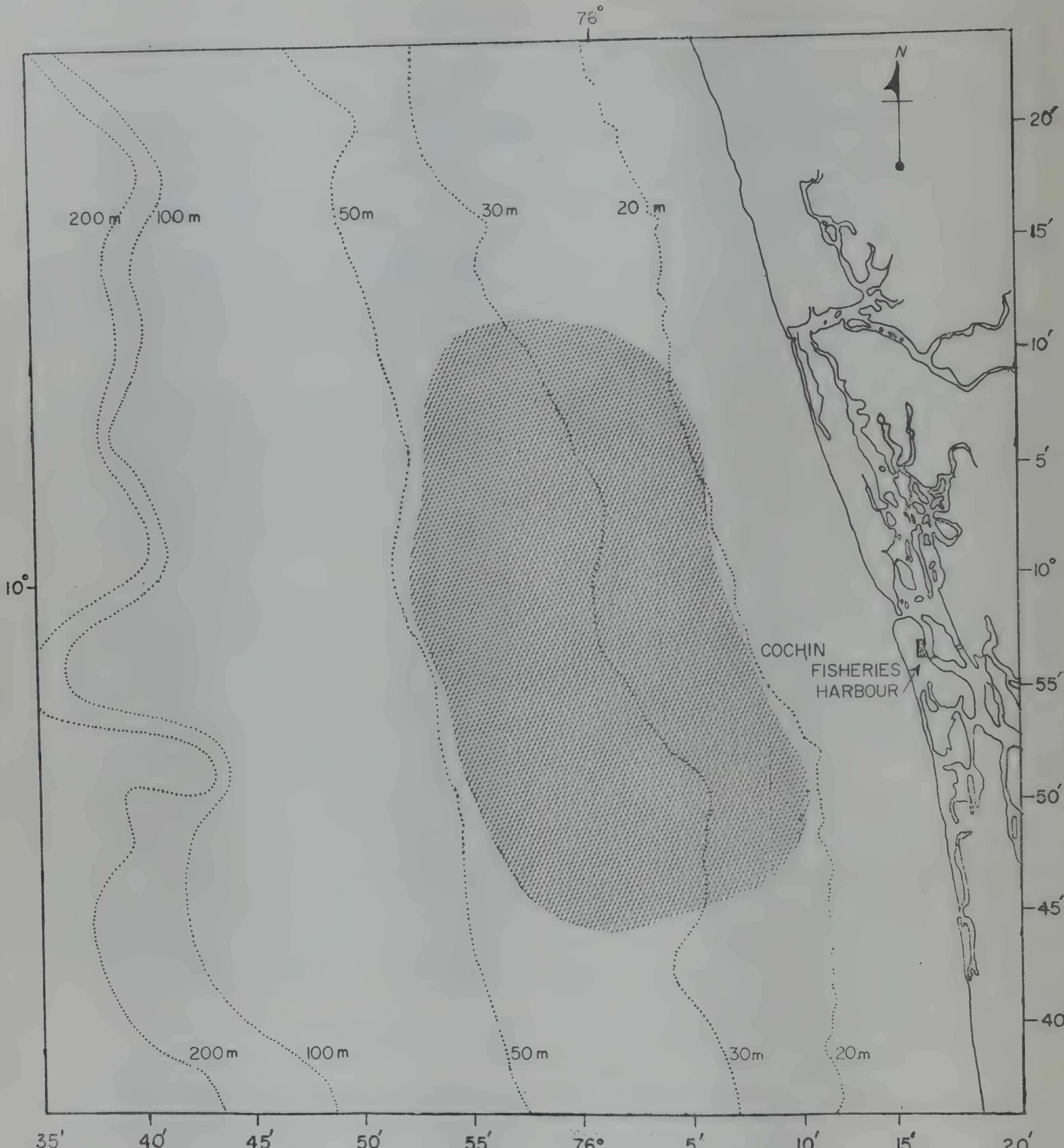


Fig. 1. Map showing the area of operation of drift gillnetters off Cochin

Regular price structure of each species were noted when the catch was unloaded are auctioned by the commission agents. Fishes such as tunas were auctioned at a price fixed per fish after separating the lot into large, medium and small specimens. By counting the number and price per fish in each lot in a boat the price per kilogram and the income for the boat was calculated. During the peak fishing season some of the larger fishes such as carangids *(Scomberoides commersonianus)* and catfishes were also auctioned by bidding the highest

price per fish. The date-wise variation in the price structure of various fishes were recorded for the monthly computation of the price structure of different species, and for the estimation of details of economics of operation.

Data regarding the cost of the boat, net and other accessories and operational expenditure were collected after interviewing 25 boat-owners and fishermen actually involved in the profession.

Fishing Fleet

Crafts

The size of the mechanised boats *(Pablo type)* operating off Cochin range from 7.62 to 9.14 m (Pl. I). Sixty percent of the boats are fitted with 'Ruston' two cylinder (24 Hp) or three cylinder (38 Hp) engines, and the rest use 'Bukh' two cylinder (30 Hp) or three cylinder (45 Hp) and 'Yanmar' two cylinder (30 Hp) engines. The mechanised boats are owned by local persons and the fishermen especially from Kanyakumari, Tamil Nadu.

Gear

Tamil Nadu fishermen own ninetyfive per cent of the gears being operated at this centre. The total length of the net varies from 800–1000 m and depth 4–8 m. During operation, usually 9–12 pieces are plied together and proper sinkers and floats are attached for maintaining buoyancy. The net is fabricated from No. 6 or 8 or 22 nylon monofilament and it is occassionally treated with indigenous concoctions made from various natural materials such as the husk of the tamarind or fruit of palm tree. Mesh size (stretched) of the net usually varies between 7 and 13 cm (Pl. I).

Operational details

The fishermen start from their base by 1600 Hrs and reach the fishing ground by 2000 Hrs. Setting and hauling time range from 1 to 2 Hrs depending on the size of the net and catch respectively. Soaking time usually range between 3 to 4 hrs. The fishermen get back to the Fisheries Harbour to unload the catch between 0600–0900 hrs.

Production

Effort distribution

An estimated total of 22,642 units were operated in 1981 but only 19,894 units were operated in 1982. Monthly distribution of the effort expended in the drift gillnet fishery during 1981 and 1982 are presented in Fig. 2. Maximum number of units were in operation during May to August which amount to 51% of the total annual effort at this centre. During the post-monsoon period, the effort expended was relatively low in both the years.

Catch

Total annual estimated landings by the drift gillnet fishery in 1981 and 1982 were 2,476 and 1,849 tonnes respectively which indicate that the annual landing sharply decreased by 25.3% in 1982 as compared to that in 1981. The annual catch per unit effort of 109.3 kg in 1981 also decreased to 93.2 kg in 1982. Monthly distribution of catch per unit effort during 1981 and 1982 is presented in Fig. 2. It is evident that relatively high values of c/f were realised in the months of April and July–October in 1981 whereas the productive months in 1982 were April, May and July–October.

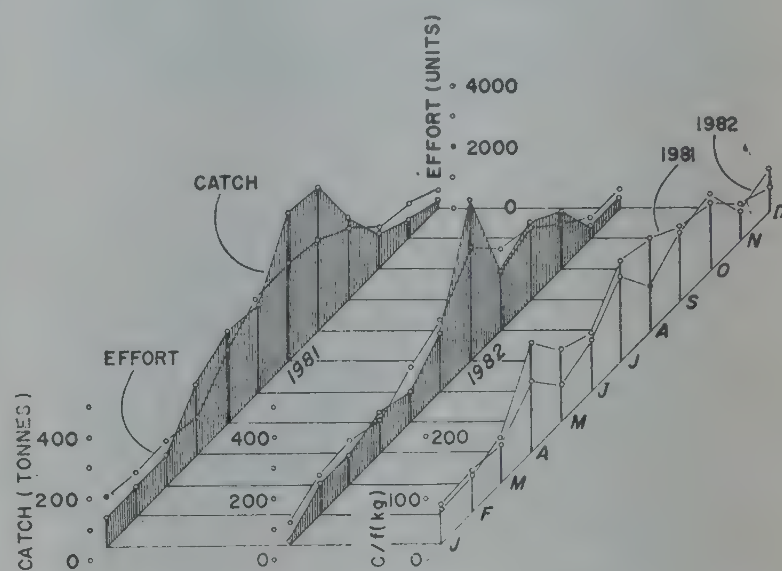


Fig. 2 Month-wise total catch and effort expended and CPUE in the gillnet fishery during 1981 & 1982

Species composition

Different species landed by the drift gillnets during 1981 and 1982 are presented in Table 1. Though the fishery has taken several species, the important groups among them were tunas and billfishes, seerfishes, catfishes, pelagic sharks, pomfrets and carangids. Cobia, dolphin fish, barracuda and wolfherring were quantitatively not significant, but were common in the drift gillnet fishery during certain months.

Annual percentage composition of major groups in the total landings during 1981 and 1982 is presented in Fig. 3. Tunas and billfishes constituted more than 45 per cent of the total landings in both the years, followed by catfishes (14%), elasmobranchs (13.5%), seerfishes (11%), carangids (6%), pomfrets (5%), mackerel (3.5%) and others (3%). The percentage composition of dolphins in the total drift net catch was not significant (1%).

Catch composition

Estimated monthly landing of different groups of fishes in 1981 and 1982 are presented in Table 2. In order to delineate the productive periods, the catch per effort of major groups during these years are presented in Figs. 4 and 5.

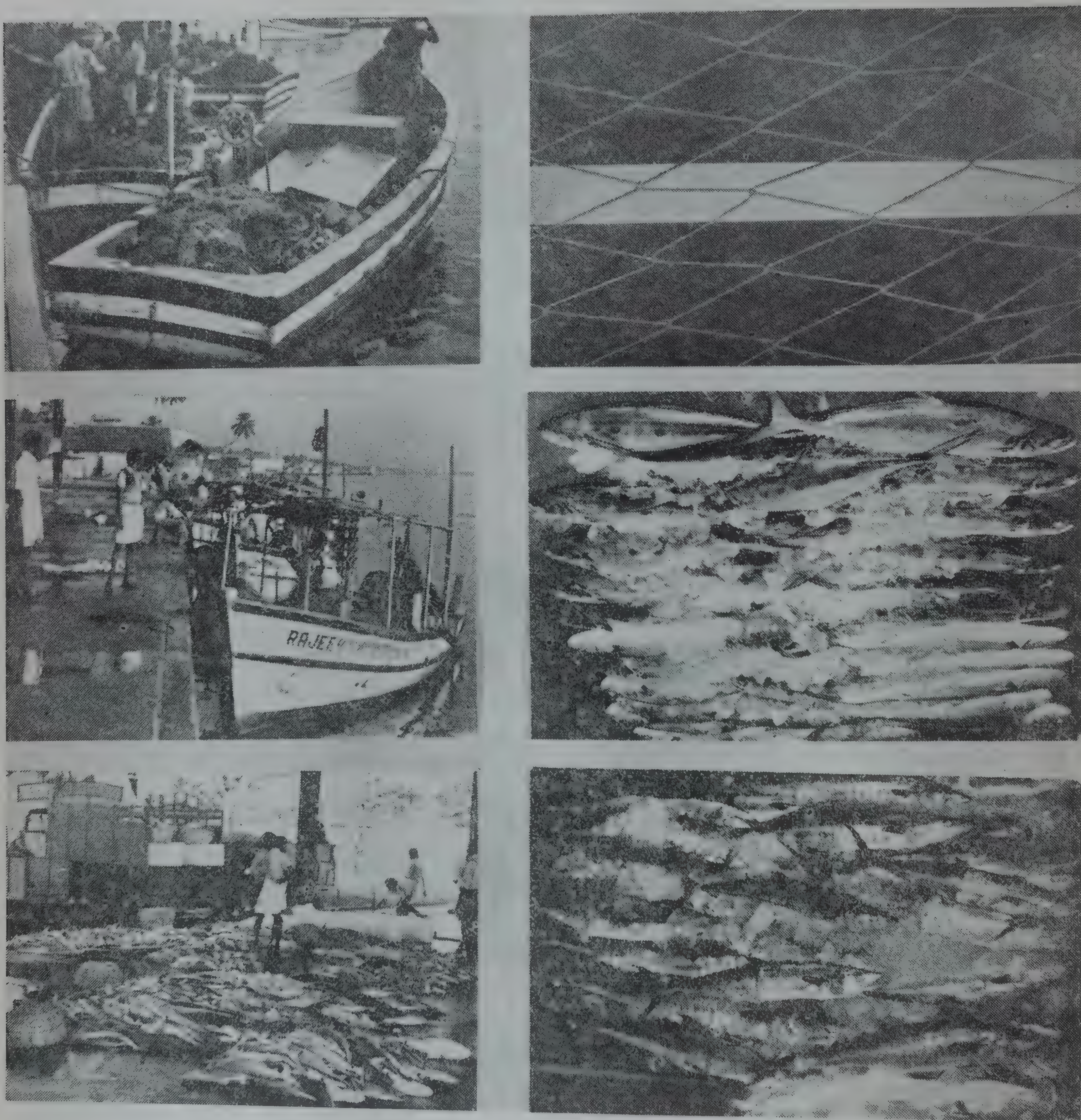


Plate I. Typical drift gillnetters, part of the net being used and different categories of fishes landed at the Cochin Fisheries Harbour.

Tunas and billfishes

The percentage contribution of tunas and billfishes to the total catch by the drift gillnet were 49.5% and 46.1% during 1981 and 1982 repectively. The estimated total landings of tunas and billfishes was 1,225 tonnes in 1981 which dwindled to 852 tonnes in 1982. Tuna catches comprised mainly of *E. affinis, A. thazard* and *T. tonggol* followed by *A. rochei, S. orientalis* and *T. albacares.* The former three species occurred in all the months in both the years whereas *A. rochei* and *S. orientalis* were present in stray numbers in the pre-monsoon period and *K. pelamis* was recorded sporadically during February to May in 1981. The percentage com-

position of *E. affinis* to the total tuna catch during 1981 was 62.6% which was reduced to 36.6% in 1982. The contribution of *A. thazard* to total tuna landings increased from 31.6% in 1981 to 57.1% in 1982. *T. tonggol* contributed to about 1.4% of the total tuna catch in both the years.

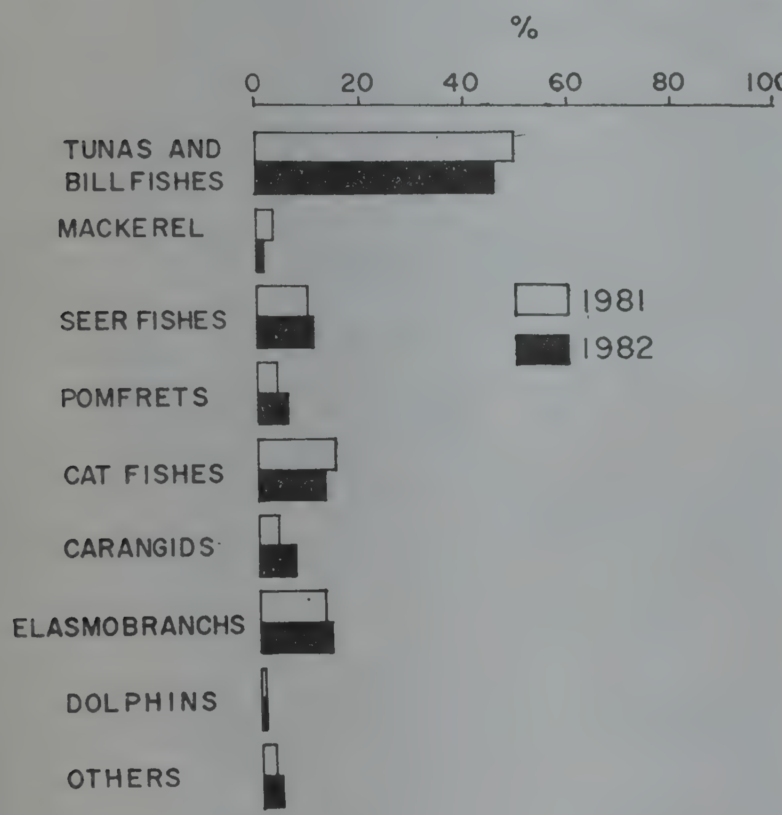


Fig. 3. Annual percentage composition of major groups of fishes landed by drift gillnet during 1981 and 1982.

Billfishes were mainly represented by the sailfish and occasionally the black marlin. The potentiality of this resouice in the inshore waters remains under exploited. Total catch of billfishes accounted for about 16 tonnes in both the years. Monthly c/f of these groups indicate that April–September period was more productive in both the years.

Seerfishes

S. commerson and *S. guttatus* supported the seerfish fishery at Cochin. *S. lineolatus* was recorded only once in January 1982. *S. commerson* dominated in the catches from August to Februaiy. It constituted the major species in the catch accounting to 97.6% and 85.8% of the total seerfishes landings in 1981 and 1982 respectively, a decline of 14% from 1981 to 1982. *S. guttatus* occurred in good numbers during August–October and this species contributed to 2.4% of the total seerfish landings in 1981 which was increased to 14.1% in 1982. The c/f of seerfishes during different months indicate that the productive period of this group was during August to April in both the years.

Pomfrets

Pomfrets were represented by two species, *Formio niger* and *Pampus argenteus* and they contributed to 4.2% and 5.3% of the annual total landings of all fishes by the drift gillnets during 1981 and 1982 respectively. The total landing of pomfrets in 1982 was 98 tonnes as compared to that in 1981 (105 tonnes) *F. niger* contributed to 91% and 71% and *P. argenteus* 9% and 29% of the total pomfret landings in 1981 and 1982 respectively. Fluctuation in the c/f of these species indicate that August–November period accounted for bulk of the catches of pomfrets in the area.

Table 1. *A check list of species landed by drift gillnets during 1981 and 1982 at Cochin*

Family	Scientific name	Common name
	Fishes	
SCOMBRIDAE	*Rastrelliger kanagurta*	Indian mackerel
	* *Scomberomorus commerson*	Narrow barred seerfish
	* *S. guttatus*	Indo-Pacific seerfish
	S. lineolatus	Streaked seerfish
	Acanthocybium solandri	Wahoo
	* *Euthynnus affinis*	Little tuna
	* *Auxis thazard*	Frigate tuna
	A. rochei	Bullet tuna
	Sarda orientalis	Oriental is bonito
	* *Thunnus tonggol*	Longtail tuna
	T. albacares	Yellowfin tuna
	Katsuwonus pelamis	Skipjack tuna
ISTIOPHORIDAE	*Istiophorus platypterus*	Sailfish
	Makaira indica	Black marlin
FORMIONIDAE	* *Formio niger*	Black pomfret
STROMATEIDAE	* *Pampus argenteus*	Silver pomfret
	P. chinensis	Chinese pomfret
ARIIDAE	* *Arius serratus*	Common catfish
	* *A. dussumieri*	Dussumieri's catfish
	* *A. thalassinus*	Giant catfish
	A. tenuispinis	Slender spined catfish
CARANGIDAE	* *Alepes djeddaba*	Djeddaba crevelle
	Seriola nigrofasciata	Black banded kingfish

Table 1 (contd)

	Caranx melampygus	Black tipped travally
	C. stellatus	
	C. sexfasciatus	Dusky travelly
	C. ferdau	Ferdau's travelly
	Elagatis bipinnulatus	Rainbow runner
	Megalaspis cordyla	Hardtail scad
	* *Scomberomorus commersonianus*	Talang queenfish
	S. tol	Slender queenfish
RACHYCENTRIDAE	* *Rachycentron canadus*	Cobia
CORYPHAENIDAE	* *Coryphaena hippurus*	Dolphin fish
POMADASYDAE	*Pomadasys hasta*	Grunts
SERRANIDAE	*Epinephelus* spp.	Groupers
LOBOTIDAE	*Lobotes surinamensis*	Brown tripple tail
MURAENOSO-XIDAE	*Congresox talabonoides*	Indian pike conger
BELONIDAE	*Strongylura crocodilus*	Fork-tail Alligator gar
	Ablennes hians	Barred needlefish
MEGALOPIDAE	*Megalops cyprinoides*	Indo-Pacific tarpon
POLYNIMIDAE	*Polynemus sextarius*	Black-spot threadfin
CLUPEIDAE	*Sardinella longiceps*	Oil sardine
SPHYRAENIDAE	* *Sphyraena jello*	Banded barracuda
CHIROCENTRIDAE	* *Chirocentrus dorab*	Wolf herring
SYNODONTIDAE	*Saurida tumbil*	Greater lizard-fish
PSETTODIDAE	*Psettodes erumei*	Indian halibut
MENIDAE	*Mene maculata*	Moonfish
TRICHIURIDAE	*Trichiurus* spp	Ribbonfish
GALEIDAE	* *Carcharinus melanopterus*	Black shark
	* *C. limbatus*	Grey shark
	C. maclotі	Hardnose shark
	* *Rhizoprionodon acutes*	Grey dogshark
	R. oligolinx	Dogshark
	* *Scoliodon sorrakowah*	Dogshark
	* *S. walbeehmi*	—
	* *Hemigaleus balfouri*	—
SPHYRNIDAE	* Sphyrna zygaena	Round-headed hammer headed shark
MOBULIDAE	* *Mobula diabolus*	Lesser devil ray
MYLIOBATIDAE	*Aetobatus narinari*	
	* *Rhinoptera javanica*	Javanese cowray
PRISTIDAE	*Pristis microdon*	Small toothed sawfish
Marine Mammals		
	Delphinus delphis	Common dolphin
	Tursiops aduncus	Spotted dolphin

* Species which occur commonly in the drift gillnet catches at Cochin.

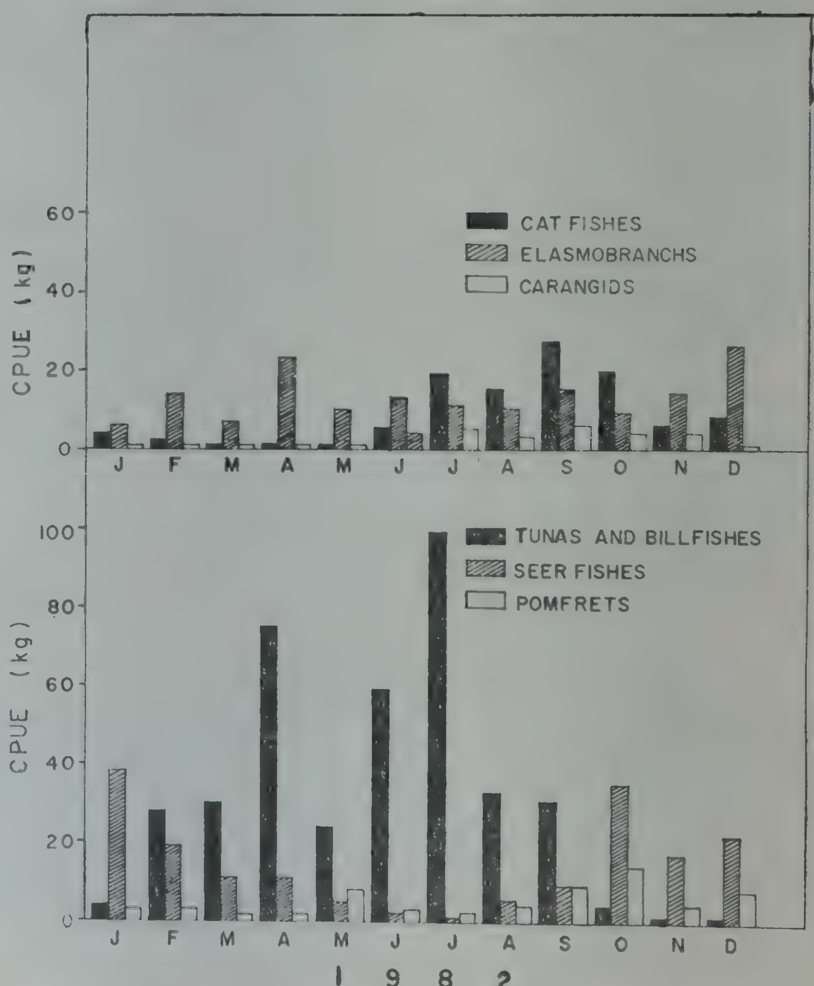


Fig. 4 CPUE of different groups of fishes in the drift gillnet fishery during 1981.

Elasmobranchs

The drift gillnet catches were invariably dominated by *Carcharinus melanoptera, C. limbatus, Scoliodon*

Table 2. *Estimated month-wise landings of major groups of fishes (in tonnes) and the effort expended by drift gillnets at Cochin Fisheries Harbour during* 1981 *and* 1982

Major groups of fishes	Year	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Tunas and billfishes	1981	0.66	2.56	3.09	171.99	219.18	296.57	339.05	159.87	110.50	13.81	5.63	2.08	1,224.99
	1982	2.50	34.33	43.27	74.83	43.86	131.44	352.45	84.67	77.65	6.34	0.59	0.14	852.07
Seerfishes	1981	23.20	16.50	10.15	8.84	12.26	1.25	15.16	89.25	8.02	17.60	22.81	10.99	236.03
	1982	23.03	22.67	15.90	10.76	9.59	3.36	3.25	12.49	22.28	55.32	12.48	13.73	204.88
Mackerel	1981	0.53	6.44	0.94	1.19	22.56	1.74	3.03	3.86	22.31	0.27	0.03	0.26	63.15
	1982	0.91	0.32	1.41	0.85	0.88	1.88	1.37	3.92	0.16	0.61	0.32	—	12.62
Pomfrets	1981	7.92	3.02	2.32	2.62	20.74	4.08	5.90	20.15	8.84	18.98	6.91	3.27	104.76
	1982	1.93	3.38	1.76	1.54	14.41	6.80	5.68	10.07	23.46	21.14	2.71	5.37	98.24
Catfishes	1981	12,51	20.57	35.14	10.18	2.62	29.21	44.70	100.52	64.90	28.05	11.84	6.81	367.06
	1982	2.12	2.12	1.57	6.52	1.31	10.88	68.25	37.64	67.22	29.96	4.04	5.33	231.08
Carangids	1981	1.47	2.46	0.12	2.26	0.48	4.21	27.85	19.99	21.44	20.31	1.37	5.24	107.21
	1982	0.64	0.71	1.42	0.90	0.80	8.72	19.82	6.90	14.10	64.52	3.03	0.39	121.95
Elasmobranchs	1981	29.22	28.54	36.64	18.73	14.82	32.04	37.54	65.94	16.74	9.95	11.79	6.86	308.82
	1982	3.61	17.00	10.44	23.54	18.16	29.34	56.60	26.42	36.14	13.54	10.14	16.65	261.59
Others	1981	7.19	7.28	8.75	3.97	5.27	3.35	7.45	3.56	6.82	5.28	2.09	1.60	62.61
	1982	1.69	2.47	7.43	5.00	10.01	5.51	7.29	6.09	11.76	3.66	1.01	1.81	63.73
Dolphins	1981	—	—	0.08	0.11	0.54	—	0.50	—	—	—	0.14	—	1.37
	1982	0.15	—	1.21	—	—	0.13	0.15	0.15	—	0.69	—	—	2.48
Total	1981	82.70	87.37	97.24	219.91	298.45	272.45	481.19	463.14	259.36	114.25	62.62	37.11	2,476.01
	1982	36.57	82.99	84.41	118.07	99.02	198.07	514.86	188.35	252.78	195.78	34.32	43.42	1,848.63
Estimated effort (Units)	1981	1,566	1,301	1,482	1,195	2,463	3,045	3,109	3,081	2,371	1,092	1,137	800	22,642
	1992	605	1,207	1,461	1,004	1,843	2,245	3,559	2,559	2,483	1,572	737	639	19,894

sorrakkowah, Rhizopriondon acutes and *Sphyrna zygaena.* Their total catch in 1981 was 309 tonnes which dwindled to 262 tonnes in 1982. Monthly fluctuations in the catch per unit of effort of elasmobranchs in the drift gillnet fishery indicate that in both the years high catches were recorded during October to March.

Catfishes

Catfishes were represented by *Arius serratus, A. dussumieri, A. thalassinus* and *A. tenuispinis* of which *A. serratus* dominated in the drift gillnet catches in both the years. The total catfish catch of 367 tonnes in 1981 sharply decreased to 231 tonnes in 1982. They were present in the landings throughout the year. However, good landings have been recorded during August–March in 1981 and July-December in 1982. Month-wise c/f indicate that July–October is the productive period for catfishes in both the years.

Mackerel

Although the mesh size of the drift gillnet employed at Cochin (7–13 cm) is not meant for small species such as mackerel, an estimated total of 63 tonnes were landed by the drift gillnets in 1981. The catch of mackerel during 1982 recorded a decline of about 69% over 1981 catches. Relatively good landings were recorded during May–September.

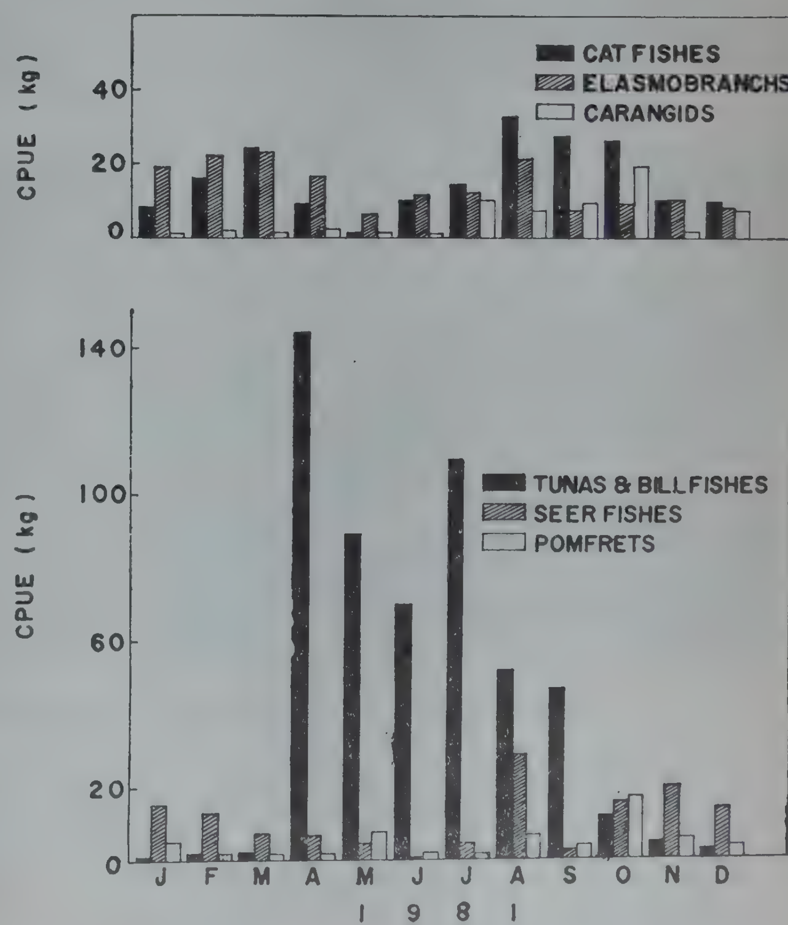


Fig. 5 CPUE of different groups of fishes in the drift gillnet fishery during 1982.

Plate II. Different categories of fishes landed are being transported from the Cochin Fisheries Harbour.

Carangids

The carangid catches comprised of commercially important species such as *Alepes djeddaba, Scomberoides commersonianus* and *S. tol*. Less common species were *Caranx melampygus, C. sexfasciatus, Carangoides gymnostethus, Elagates bipinnulatus, Megalaspis cordyla* and *Alectis ciliaris*. During June to October they were available in good numbers in the fishery in both the years. Their c/f indicate that the productive period for carangids in the drift gillnet fishery at Cochin was during July to October.

Other fishes

Among other groups of fishes which constituted quantitatively less significant were cobia, dolphin fish, barracuda and wolfherring which were represented in the fishery in scattered numbers more or less throughout the year. Other species such as *Pomadasys hasta, Lobotes surinamensis, Megalops cyprinoides, Saurida tumbil, Psettodes erumei* and *Trichiurus* sp. were present in the landings in scattered numbers during certain months of the year.

Incidental catch of dolphins

Dolphins belonging to the species *Delphinus delphis* and *Tursiops aduncus* were accidentally caught by drift gillnets and they were landed in stray numbers during certain months. They constituted about 1% of the total drift gillnet landings in both the years. No seasonal periodicity in the catch could be attributed to this group.

Disposal and Marketing

The fish catches are auctioned at the Fisheries Harbour. The commission agents fix up the prices for the quality fish and maintain all the accounts regarding the price realised, expenditure and bata paid to the fishermen and settle the accounts with the owners and fishermen once in a week, mostly on Saturdays. Major part of the quality fishes such as seerfish and pomfrets are distributed to the local markets, cold storages and hotels in and around Ernakulam, Alwaye and Muvatupuzha through bicycles, autocarrier and tempo vans. Major share of tunas are transported by lorries to the southern parts of Kerala especially to the markets at Quilon and Trivandrum districts. Catfishes and sharks are chiefly transported to the markets in the northern parts of Kerala such as Kunnamkulam, Patambi, Tellicherry and Cannannore. (Plate II) Fins of bigger sharks are removed first and the flesh lump salted and dried at Fort Cochin.

Economics of operation

The drift gillnet fishery is an enterprise, managed by fishermen who are actually involved in the fishing operations and the non-fishermen who are profited by investments, and which produce food for the society and a source of income for the participants. For the purpose of assessing the economics of operation of drift gillnetters and to evaluate the share of income for the participants in the fishery, information was gathered on the fluctuation in the price of major groups of fishes, operational expenditure and income from the fishery during the period 1981 and 1982 and the data analysed.

Yearly fluctuation in the total catch, price realised through the sales and price per tonne of major groups of fishes at Cochin Fisheries Harbour during 1981 and 1982 are presented in Fig. 6. During 1981, the price of 2,476 tonnes of fishes was 7.17 million rupees while in 1982 1,849 tonnes of fishes fetched 7.82 million rupees.

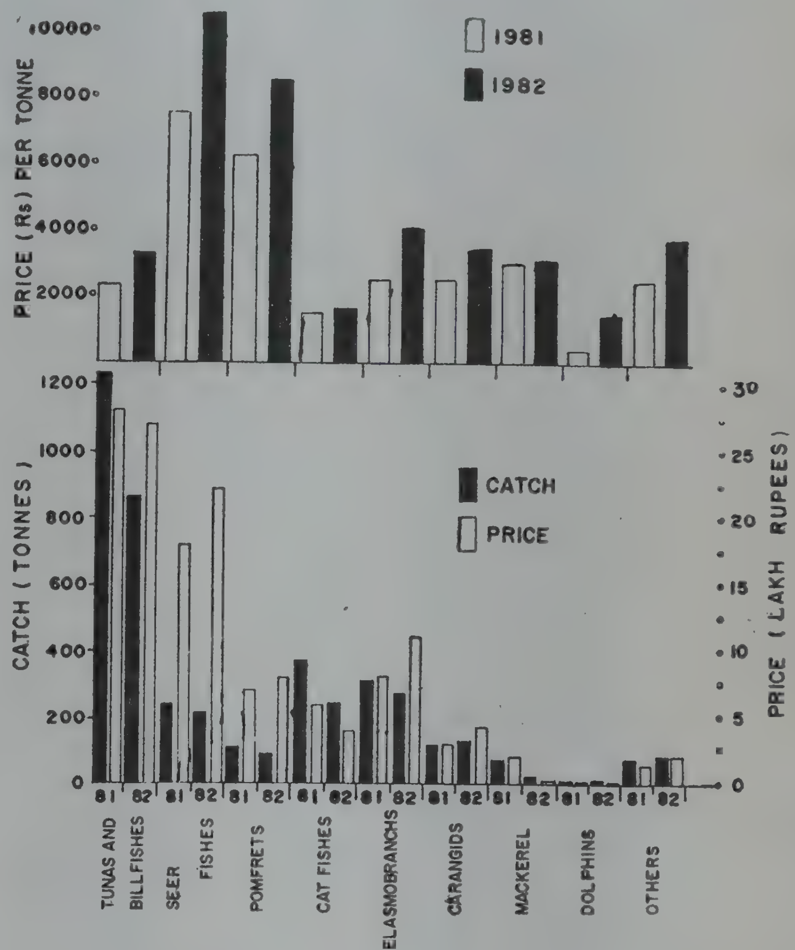


Fig. 6. Annual catch (tonnes), price (lakh rupees) *(lower panel)* and fluctuation in price per tonne *(upper panel)* of major groups of fishes landed by drift gillnetters during 1981 and 1982.

Annual fluctuation in the price per tonne of major groups indicate that except for mackerel and catfish the price of other fishes increased sharply in 1982 as compared to that in the previous year. Of these groups, distinct price difference was observed for tunas and billfishes, seerfishes and pomfrets.

In order to estimate the monthly fluctuation in the price of fishes at the Cochin Fisheries Harbour, information was also collected on these lines for major groups of fishes for 1981 and 1982 and the results presented in Tables 3 and 4. In both the years seerfishes, pomfrets, mackerel, catfishes and carangids evinced considerable fluctuation in the pattern of price during different months.

Often we are posed with the question about the economic viability of the operation of drift gillnetters. In this report, an attempt has been made to present the economics of this fishery based on the operation of private drift gillnetters at Cochin (Table 5).

Table 3. *Monthly fluctuation in the total catch, price realised and price per Kg. of fish at the Fisheries Harbour, Cochin during* 1981 *and* 1982.

Month	Year	Catch (tonnes)	Price realised (in 1000 Rs.)	Price per kg. (Rs.)
Jan.	1981	82.7	318.3	3.8
	1982	36.6	264.0	7.3
Feb.	1981	86.9	335.9	3.8
	1982	83.0	450.8	5.4
Mar.	1981	97.7	341.7	3.5
	1982	84.4	414.5	4.9
April	1981	219.3	607.8	2.8
	1982	118.1	579.6	4.9
May	1981	298.9	1,010.3	3.4
	1982	99.0	482.5	4.9
June	1981	272.5	509.0	1.9
	1982	198.1	858.7	4.3
July	1981	481.2	1,281.7	2.7
	1982	514.8	1,719.7	3.3
Aug.	1981	463.1	1,250.3	2.7
	1982	188.3	840.7	4.2
Sep.	1981	259.6	744.6	2.9
	1982	252.8	927.7	3.7
Oct.	1981	114.3	346.7	3.0
	1982	195.8	811.8	4.1
Nov.	1981	62.6	283.2	4.5
	1982	34.3	211.3	6.5
Dec.	1981	37.1	143.8	3.9
	1982	43.4	263.6	6.1
Total	1981	2,476.0	7,173.5	2.9
	1982	1,848.6	7,824.8	4.2

The inputs in the drift gillnet fishery are the (1) fixed capital which includes cost of vessel and gear, and (2) operational expenditure including fuel cost, maintenance, depreciation on capital and administrative expenses. The benefits are the value of the output in the form of income and the profit on income. In the present analysis, direct cost and direct benefit relating to the value of the catch only are taken into consideration.

Under direct costs, the fixed capital for the investment for the vessel and gear has been considered to be between Rs. 75,000–80,000 and Rs. 25,000–30,000 respectively. Under recurring operational expenditure, the price of fuel, maintenance of the craft and gear, depreciation on capital and port dues are included which amounts to 0.066 million rupees per boat per annum. The annual revenue has been calculated by estimating the landed value of the fish at about 0.963 million rupees (average for 1981 and 1982) per boat per annum and the profit by operation per boat operating for about 280 fishing days per annum at the Cochin Fisheries Harbour has been estimated as 0.031 million rupees. From this the profitability was found to be ~~32.41~~% per 31.10 boat. However, keeping in mind the fluctuation in the fishing season and non-recurring expenditure such as unforeseen breakdown, loss of nets and fishing days, the annual net profit of drift gillnet can be rounded off to Rs. ~~31,222~~ and the net profit from the fishery less 29,92 commission paid for agents has been estimated as Rs. ~~29,661~~ per annum which is shared by the boat owner, 28,4 the crew and the net owner on a 33.3 percent basis.

Strategies for future development

While the gillnet fishery is showing profitability, we feel that there is need for critically examining some areas for improvements in production, quality and enhanced returns for the catches.

(i) Storage facility

When there is good catch (300 kg or more per boat), nearly 10–15% of the catch is landed in deteriorated condition which realises very low price. Species such as *Auxis rochei* and *Rastrelliger kanagurta* are easily damaged due to dumping of the catch on the deck space between the engine cabin and sides of the vessel. The boats do not carry any ice, nor has any special study been made whether this would be feasible. The problem merits serious consideration to advise the fishermen how the quality of the catch could be maintained and improve ways of storing the same. Carrying ice boxes may not be a solution. Perhaps, some structural modifications of the boat have to be considered without being detrimental to the stability of the boat.

Before advising the gillnet fishermen some trials to study the economics taking into consideration added inputs would be necessary.

(ii) Area of operation

Our study has clearly shown that these boats will not be able to increase their area of operation due to limitations mainly with regard to fuel intake capacity. Alternate use of energy saving device, namely use of sails has not been tried on these boats and this is an area which needs some attention.

(iii) Soaking time

Normally only one operation is carried out allowing for a soaking time of about 3–4 hrs and when good fishing is expected during the months of May–July, the soaking time is reduced to about 2 hours, so that atleast two operations are carried out. This method again

results in deterioration of the catch from the first operation and very low value realisation. Hauling is manually done and is time consuming, taking anywhere from one to two hours depending on the catch. The point is whether it is desirable to have longer soaking time by reducing hauling time. One way by which hauling time could perhaps be reduced would be by the installation of a suitable mechanical hauler.

(vi) Social aspects

Despite the good price that the gillnet catch fetches, some amount of indebtedness of the fishermen to the middlemen still exists. It is not uncommon for these fishermen to draw an advance at the time of settling of the accounts by the fishermen from boat owners and auctioneers (middlemen). Since majority of the fishermen are from Tamil Nadu, there is need for looking into the socio-economic problems faced by these category of fishermen.

Table 4. *Month-wise fluctuation in the price of major groups of fishes and dolphins (in thousand Rs. per tonne) landed by drift gillnets at Cochin Fisheries Harbour during* 1981 *and* 1982

Major groups of fishes	Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Tunas and billfishes	1981	3.00	3.59	3.28	2.41	2.80	1.77	2.44	1.79	2.30	1.98	2.96	2.36
	1982	3.03	3.29	3.42	3.48	2.95	3.34	3.25	3.24	3.16	3.11	3.07	3.07
Seerfishes	1981	7.13	9.06	9.94	9.81	10.32	6.68	8.11	6.61	8.02	6.59	7.10	7.07
	1982	9.40	9.97	10.07	10.51	11.60	12.04	12.73	12.99	8.41	8.46	9.34	10.49
Mackerel	1981	3.00	3.16	3.20	2.90	2.71	4.80	3.16	2.28	2.85	2.90	3.00	2.99
	1982	3.05	3.14	3.02	3.12	3.01	3.63	3.57	3.06	2.01	3.02	3.00	—
Pomfrets	1981	6.20	7.33	7.27	6.51	6.57	5.80	7.38	5.27	7.04	5.65	6.62	5.94
	1982	6.14	7.82	6.94	10.72	8.48	9.28	10.63	10.23	9.06	7.07	7.55	8.32
Catfishes	1981	1.34	1.95	1.83	1.80	1.24	1.17	1.46	1.05	2.40	0.89	1.44	0.77
	1982	1.00	1.94	2.87	1.51	1.50	2.81	1.92	2.13	1.00	0.95	1.50	1.50
Carangids	1981	2.65	2.09	1.44	2.11	1.33	1.37	3.05	1.24	2.85	1.66	0.30	1.23
	1982	2.11	3.83	3.12	4.16	4.24	4.72	6.24	3.14	2.11	2.76	2.93	3.04
Elasmobranchs	1981	2.12	2.16	3.07	2.70	3.17	2.16	2.89	1.78	3.85	2.31	2.83	3.22
	1982	3.12	3.83	3.91	5.27	3.93	5.31	4.30	4.95	2.85	3.50	3.27	3.81
Others	1981	2.29	3.93	4.28	3.28	3.39	4.73	2.27	2.33	2.71	2.75	3.75	3.26
	1982	2.61	4.47	4.10	5.54	3.84	3.89	4.07	4.22	2.40	3.00	3.00	3.70
Dolphins	1981	—	—	0.90	0.90	0.80	—	1.04	—	—	—	0.79	—
	1982	1.38	—	1.42	—	—	2.17	1.55	1.26	—	1.22	—	—

(iv) Bottom set gillnet fishery

Although during the seerfish fishing season (September-November) the fishermen operate their nets using more number of sinkers to set the net in the sub-surface layer, no attempts have been made to develop bottom set gillnet fishery in this area. Trials are called for so that the resources which could be exploited thus could be identified and information made available.

(v) Diversification

We have been speaking of diversification, and effort to be reduced on shrimp trawling. The conversion of mechanised boats involved with shrimp trawling to efficient gillnetters with mechanised hauling system also needs consideration. Since these boats range in size from 9.6–13.0 m, the operational range, better storage facilities and longer stay away from port could be thought of.

From late December 1983 a few motorsied canoes with 5-6 persons have conducted drift gillnet fishing from closer inshore. There is need to see to what extent such diversification could be integrated in the existing fishery in the small scale sector.

Table 5. *Cost benefits in the operation of drift gillnetters at Cochin* 1981–1982 *(per boat per annum)*

A. *Fixed capital (Rs.)*

i) Cost of the vessel including hull, engine and accessories	:	75,000–80,000
ii) Cost of the gear including accessories	:	25,000–30,000

B. *Operational expenditure (Rs.)*

Recurring

i) *Fuel*

a) Engine running hours (Av. 7 hrs/day for 280 fishing days)	:	1,960
b) Fuel consumption at the rate of 4.75 litres/hour	:	9,310
c) Total fuel cost (Rs.) (Av. Rs. 2.53/litre)	:	23,554.30

d) Cost of lubrication oil (Rs.) (1.6 litres/week at the rate of Rs. 9.55 per litre)		445.60
e) Bata for crew (3-4 men) (Rs.) (Consolidated amount of Rs. 30/- per day)		8,400.00
ii) *Maintenance (Rs.)*		
a) Vessel @ 2% average for hull and accessories and @ 5% average for engine and accessories	:	5,425.00
b) Gear @ 10% average for the net	:	2,750.00
iii) *Depreciation on capital* (Rs.)		
a) Hull and engine (@ 20%)		15,500.00
b) Net and accessories (@ 33.5%)	:	9,212.50
iv) *Administrative Expenses* (Rs.) Port dues	:	1,050.00
Total		66,337.40

C. *Annual income (Rs.)*		
Total catch (kg.) (@ daily 95.5 kg. for 280 fishing days)	:	26,740.00
Revenue (@ Rs. 3.60/kg.)	:	96,264.00
D. *Profit (Rs.)*		
Profitability %	:	31.10
Rate of return %	:	28.50
Investment: Turnover ratio	:	1.0:0.92
E. *Pay back period (years)*	:	3.51
F. *Profit allocation (Rs.)*		
i) Profit	:	29,926.60
ii) Share of the commission agents (@ 5%)	:	1,496.30
iii) Profit less the commission	:	28,430.30
iv) Share of the boat owner (@ 33.3%)	:	9,476.77
v) Share of the crew (@ 33.3%)	:	9,476.77
vi) Share of the net (@33.3%)	:	9,476.77

LARVAL REARING AND SPAT SETTLEMENT OF BROWN MUSSEL *PERNA INDICA* IN THE LABORATORY*

Earlier work at the Central Marine Fisheries Research Institute has proved the great potential for mussel farming in the coastal waters of India. The brown mussel *Perna indica* is one of the two species occurring in India, but with a narrow distribution along the extreme south-west coast. The inadequacy of mussel seed in the wild is one of the constraints for taking up commercial mussel farming. Initial success has been achieved in the artificial breeding of the brown mussel and spat have been raised in the laboratory.

Spawning in this species commences from May and lasts till August, with a peak during June–July. Induced spawning in the laboratory in June was achieved by thermal stimulation by keeping mature animals at 31°–34°C. Sudden change in temperature induced spawning at 34°C. But the eggs developed only upto veliger stage and were not healthy. In July, the mussels spawned in the tanks naturally without any external stimuli. Males spawned first. The milt was expelled in a jet. The eggs were liberated usually in two or three spells, at intervals ranging from 30 minutes to 3 hours. The eggs were spherical and brick red in colour and measured 45-60 μ. The milt was mixed with the eggs kept in beakers with filtered sea water and fertilization took place immediately.

Trochophore larvae were noticed within 7 hours after fertilization. Within 20 hours early veliger stage was observed in the larval rearing tanks and the larvae were D-shaped within 24 hours (Fig. 1). The larvae measured 70-76 μ in the antero-posterior axis and 62 to 65 μ in dorso-ventral axis. Early umbo stage was observed from 7th day onwards (Fig. 2). Late umbo stages

*Prepared by K. K. Appukuttan, T. Prabhakaran Nair and K. T. Thomas

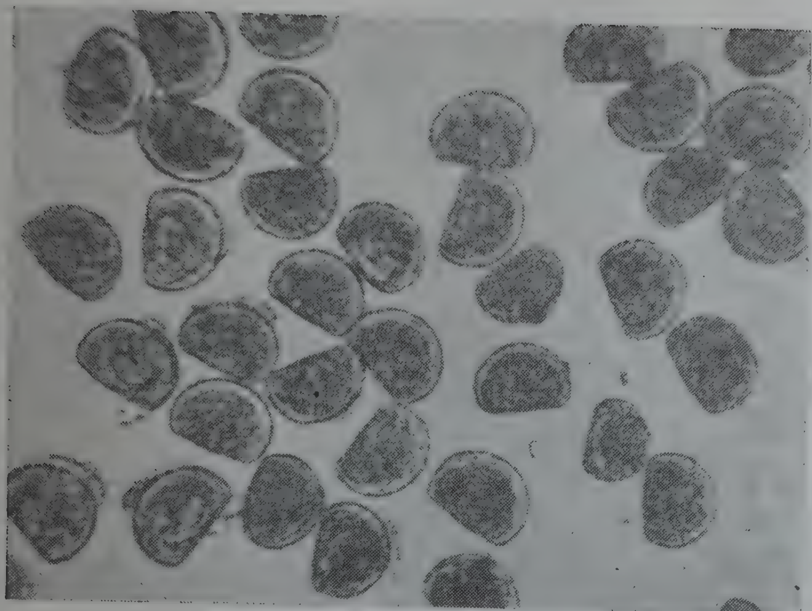


Fig. 1. D-shaped veliger larvae of *Perna indica*

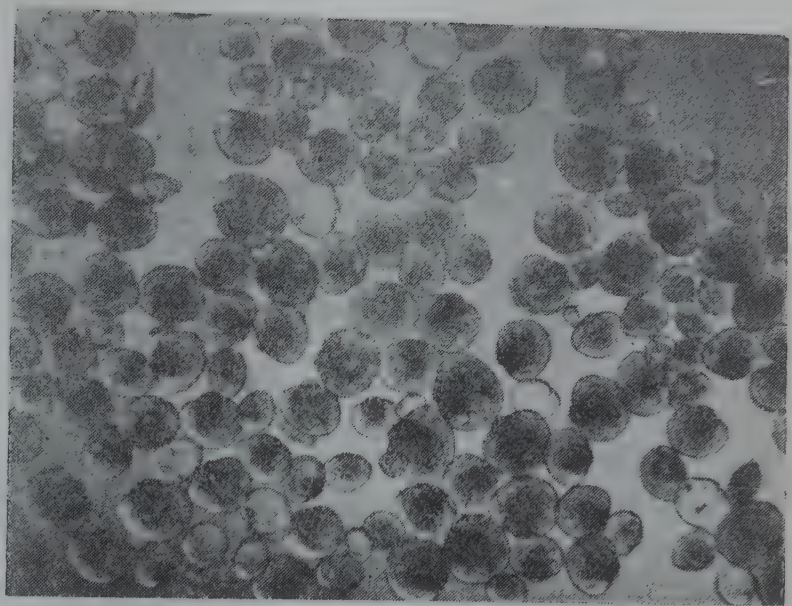


Fig. 2. Umbo larvae of *P. indica*

were noticed from 9th day and larvae measured 200 μ in the antero-posterior axis. The larvae showed a thick greenish yellow digestive gland in the antero-dorsal region visible through the transparent shell. Larvae reached eyed stage by 13th day with a characteristic dark pigmented eye spot ventral to the digestive gland. The valves were more convex with concentric striation and the antero-posterior axis measured 208 to 261 μ and dorso-ventral axis 200 to 260 μ. From 16th day onwards pediveliger stages were found in the rearing tanks. This stage was characterised by the slightly oblique valves, protruding foot and reduced velum. Shell became thick and brown colouration started appearing in the valves. On 17th day the largest pediveliger measured 489μ in the antero-posterior axis and 437μ in the dorso-ventral axis. The larvae crept at the bottom of the tanks with the help of foot and aggregated near the points of aeration. The velum had disappeared totally and the larvae started settling on clutches viz., nylon mono-filament, plastic sheets, granite pebbles, mussel shells and glass plates by 21st day. The spat have attained characteristic shape and brown colour of the adult (Fig. 3). Good settlement of spat was observed in the bottom of the rearing tanks also. The maximum length of spat observed on 21st day was 780 μ. By 32nd day the maximum size of the spat in the rearing tanks was 2.7 mm.

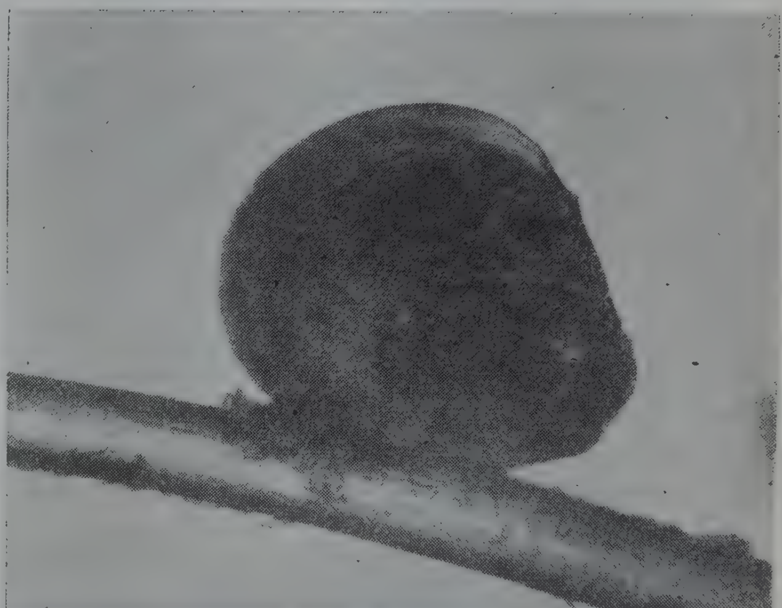


Fig. 3. Young spat of *P. indica* settled on monofilament.

For larval rearing sea water filtered through 40 μ bolting silk was used. Fibre glass tanks of 50 l capacity were used as rearing vessels and sea water was changed once daily and aerated well. The larval density was 10,000–15,000 per litre upto 5th day and became reduced to 5,000–6,000 per litre afterwards. Feeding of larvae with micro algae *Isochrysis galbana* and *Pavlova* sp. was started from the straight-hinge veliger stage. The total cell count per microlitre varied from 71 to 120 cells. The quantity of algae fed was increased gradually as the larvae grew to umbo, eye spot and pediveliger stages. Phytoplankton, with additional inoculation of *Isochrysis,* cultured in open tanks was given for the spat from 29th day onwards. Further research has been taken up to standardise water quality, larval density and food concentration to achieve maximum settlement and survival.

MARINE MAMMAL NEWS

Dear Reader,

During the last few years a number of strandings of whales, dolphins, and porpoises have been detected and same have been reported along our coasts. The accidental capture of dolphins and the dugong in fishing operations have also been reported. These marine mammals are protected under the Indian Wild Life (Protection) Act 1972, and trade in many of the marine mammals is also banned or controlled under the Convention of International Trade in Endangered Species of Fauna and Flora (CITES).

The Central Marine Fisheries Research Institute has the National Marine Living Resources Data Centre (NMLRDC) for the acquisition, storage and dissemination of information on living resources from our Exclusive Economic Zone (EEZ). The Institute has also a network of field centres all along the coast numbering over 40, which facilitates the acquisition of field data. With this facility supplemented by observations from various organisations interested in the marine sector, it is hoped to build up a National Data Centre for marine mammals and sea turtles at the Central Marine Fisheries Research Institute as part of the NMLRDC.

Under this programme on marine mammals it is proposed to have the following:

1. Monitoring of strandings of whales, dolphins, porpoises and the dugong.
2. Monitoring of incidental catches of dolphins, porpoises and the dugong in fishing operations.
3. Determining the effects of marine pollution on cetaceans and dugong. This will also involve biochemical analysis of body parts for assessing uptake of pollutants from carcasses.
4. Biology of cetaceans and dugong with emphasis on food and feeding, maturing, age, growth and reproduction.
5. Behaviour and social structure.
6. Acquisition of data from ship board observations.
7. Assessing the role of marine parks and reserves on cetaceans and the dugong in coastal waters.
8. Examining the legal frame work under which protection, conservation and management would be possible.
9. Benign research and ways and means of non-consumptive utilization of the resource.
10. Rapid dissemination of information on marine mammals.

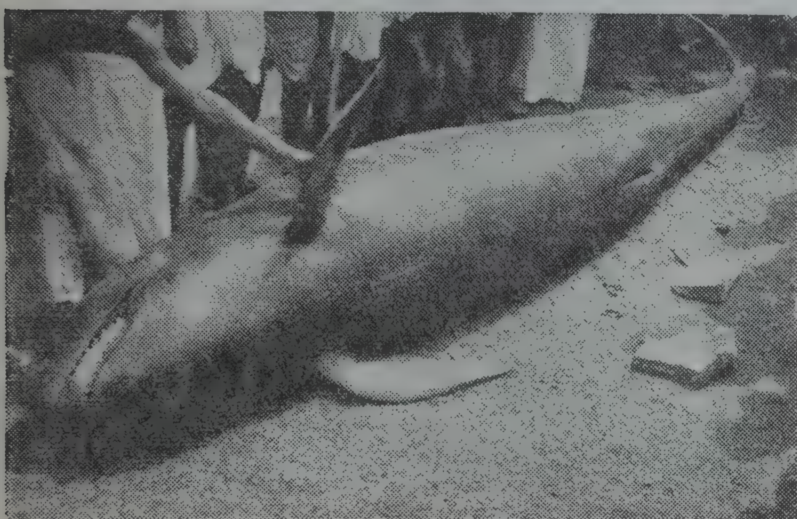
It is proposed to give full credit to those who send such observations. The accumulation of data from various sources on cetacean stranding and accidental capture could throw a considerable amount of light on their life habits and behaviour. We would also like to publish good photographs of the specimens which could also help in establishing the proper identity of the species. With this in view, I solicit your co-operation in sending us your observations on marine mammals which could enhance our knowledge about their life habits and behaviour.

In this issue we are documenting a few strandings of lesser cetaceans (the false killer whale *Pseudorca crassidens)* from along our coast.

E. G. Silas
Director

1. Stranding of *Pseudorca crassidens* at Calicut, Kerala

The fishermen of Puthiappa, a fishing village 5 km north of Calicut saw a whale stranded on 28–7–1975 at about 3.30 in the afternoon. It was dragged ashore and was left in a tidal pool of about ½ x 50 x 20 m. After struggling in the pool for about two hours it died. It was identified as false killer whale *Pseudorca crassidens* (Owen) (Fig. 1 & 2). After taking its detailed morphometric measurements, the whale was burried for taking its skeleton.



	Measurements in cm	% of total length
Total length	423	
Tip of snout to origin of flippers	74	17.47
,, ,, dorsal	184	43.48
,, ,, eye	43	10.27
,, ,, blow–hole	50	11.90
,, ,, genital pore	243	57.48
,, ,, annus	275	64.99
Length of flippers		
anterior margin	63	14.97
posterior margin	41	9.82
width at base	20	4.84
vertical height	56	13.34
Dorsal fin		
anterior margin	52	12.32
posterior margin	21	5.07
width at base	44	10.43
vertical height	26	6.18
Caudal fin		
spread of caudal length	85	20.07
Girth of body		
at flippers	175	41.52
at anus	120	28.45
Eye diameter	3	0.80
Diameter of blow-hole	5	1.18
Cleft of mouth	38	9.09
Distance between eye to mouth	7	1.77
,, ,, eye to blow–hole	35	8.38
,, ,, genital slit and anus	32	7.74
Length of genital slit	30	7.22
Length of small intestine	1466	346.24
Length of large intestine	804	189.89

Dentition $\frac{9 + 9}{10 + 10}$

The stomach content was analysed and found to contain semidigested matter including remains of the catfish *Tachysurus* sp. A biochemical analysis of the muscle, liver and blood was attempted and the results are as follows:

	Fat (Moisture free base in %)	Protein	Ash	Acid insoluble
Muscle	10.50	84.57	1.95	0.24
Liver	26.00	64.43	3.17	0.12
Blood	1.54	85.24	0.50	0.11

The authors are thankful to Dr. G. Seshappa for his help during the study.

Reported by R.S. Lal Mohan, K. V. Somasekharan Nair and P. Ramadoss.

2. Stranding of *Pseudorca crassidens* at Rameswaram, Gulf of Mannar

On 18th October, 1975 at 08.00 hrs a whale was seen struggling near Rameswaram in Gulf of Mannar and was towed to the shore (Fig. 3), By the time the whale was brought to the shore it died.

Occasional strandings of whales have been reported by several authors along the Indian coasts. The present specimen was identified as a male of the false killer whale *Pseudorca crassidens* (Owen). The diagnostic characters of the species are the head tapering anteriorly into a rounded snout, the teeth large, powerful, circular in cross section and 8 to 11 pairs in upper and lower jaws, the dorsal fin small, directed backwards and with a concave posterior border and dark black body colouration. In the specimen, eight pairs of teeth were present in the upper jaw. In the lower jaw there were ten teeth on right side and eleven teeth on left side. The front five pairs of teeth in each jaw were blunt.

The morphometric measurements are given below:

	Measurements in cm
Total length (from tip of snout to fork of caudal flukes)	384
Snout to origin of dorsal	160
Snout to origin of flipper	70
Snout to front end of eye slit	45
Diameter of eye	4.5
Snout to anterior margin of blow-hole	50
Snout to penis	194
Snout to anus	247
Snout to origin of upper jaw	42
Snout to origin of lower jaw	39
Width of blow-hole	8
Base of dorsal	53
Anterior margin of dorsal	55
Height of dorsal	30
Base of flipper	19
Length of flipper from anterior insertion to tip	55
Breadth of the flipper at the middle	21
Horizontal length of flukes	89
Girth at the dorsal origin	165
Length from the lower base of the flipper to the tip	40
Length from the anus to caudal fork	129
Length from origin of dorsal to caudal fork	224
Length from origin of flipper to caudal fork	308
Girth at the genital slit	139
Girth at the caudal peduncle	44
Girth at the origin of the flipper	141
Penis length	44
Penis girth at the base	20
Penis tip narrow, penis girth at the tip	1

Reported by R. Thiagarajan,
P. Nammalwar and
K. M. S. Ameer Hamsa.

3. Capture of a false killer whale *Pseudorca crassidens* at Port Blair, Andamans

On 27-7-76, when one of the mechanised fishing vessels belonging to the Andaman and Nicobar Administration set gill nets off Maduban near Port Blair two false killer whales belonging to the species *Pseudorca crassidens* (Owen) were entangled. One of them, however, escaped when trying to bring them ashore.


A


D

False killer whale has a world wide distribution, It is a truely oceanic form and is gregarious in nature, moving in schools. The present record (Fig. 4) is the first of its occurrence from the Andaman Sea.

Some of the measurements (in cm) of the whale are given below:

Total length	396
Distance from the tip of the snout to the origin of dorsal	139
Distance from the tip of the snout to the eye	48
Distance from the tip of the snout to the angle of mouth	33
Distance from the tip of the snout to anterior insertion of the flipper	57
Breadth of flipper	20
Length of flipper	43
Width of the body	66
Breadth of the dorsal fin	43
Height of the dorsal fin	23
Distance between the posterior margin of the flipper and the anterior margin of the dorsal fin	71
Distance from the posterior margin of the dorsal fin to the notch of the caudal fluke	183
Width of the caudal fluke	23
Length of the largest tooth	10
Diameter of the blow-hole	5

When the stomach was cut open the head of a Barracuda and tail portion of a Carangid fish were found in semidigested condition (Fig. 5).

Reported by D. B. James

Compiled and prepared by M. J. George, G. Subbaraju & S. K. Dharmaraja
Published by Dr. M. J. George, Senior Scientist on behalf of the Director, Central Marine Fisheries Research Institute, Cochin-682 018 and printed at PAICO, Cochin-31

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MARINE FISHERIES INFORMATION SERVICE

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1984

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

COCHIN, INDIA

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the National Marine Living Resources Data Centre (NMLRDC) and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

Abbreviation – *Mar. Fish. Infor. Ser. T & E Ser.*, No. 56: 1984

CONTENTS

Cover photo: Course study class in progress

FAO/DANIDA/ICAR National Training Course on Fish Stock Assessment

Held during

7 November 1983 - 9 December 1983

at

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

COCHIN - 682 018

PREFACE

Assessment of fish stocks assumes all the more importance on global level when the limitation on the available land mass to feed the increasing population is felt. In addition, fish is protein rich and relatively cheap when compared to other cereals. Fish stocks being a renewable resource should therefore be scientifically exploited on sound management approach. The factors affecting fish stocks other than human intervention such as fishing, oil and mineral exploration and pollution have also to be taken into account while studying their conditions.

For this purpose mathematical models are available and to estimate the parameters involved statistical techniques have been developed. In studying fish stocks in temparate waters these models and techniques have been extensively used. In case of tropical regions ageing of fish has always posed problems and this has stood in the way of proper assessment of stocks.

In order to make a break through, length frequency analysis has been developed and this approach is used in studying tropical stocks. Though this approach has its own limitations, as any other models for that matter, it serves at least as a first approximation in assessing the impact of fishing on the stocks.

With this view FAO in collaboration with Danish International Development Agency, Denmark has started training courses on fish stock assessment wherein workers dealing with this aspect in their research or teaching programmes have been taken as participants. These participants have been exposed to extensive material dealing with the models and methods of arriving at estimates of parameters using programmable pocket calculators. Such calculators are provided to each one of the participants so as to have first hand knowledge of arriving at estimates independently by each one of them. Another important aspect of these training courses is the case study approach in which published material is considered for detailed study to bring out the merits and the demerits of the approach in these case studies and to point out the methods of improving the same. By this approach an insight in depth in analysing data on fish stocks is obtained by the participants.

Five weeks FAO/DANIDA/ICAR National Training Course on Fish Stock Assessment is one such training course organised by FAO, DANIDA and ICAR for the benefit of Indian Scientists dealing with fish stock assessment either in their research programmes or teaching courses or in both. For this purpose workers from various Agricultural Universities and Research Organisations have been selected as participants. In the faculty in addition to FAO/DANIDA experts there were three Indian course instructors.

This National Training Course organised at CMFRI commenced on 7, Nov. 1983 and concluded on 9, Dec. 1983. There were altogether 25 participants. I am sure that this Training Course will have a great impact on the participants so as to generate new thinking in studying tropical fish stocks and result in improved as well as new models for the proper assessment of the fish stocks. In the following pages are given the proceedings of the training course. This course, though had a serious bearing throughout, was not without lighter moments some of which are also recorded for the benefit of the readers.

I take this opportunity to thank FAO, DANIDA and ICAR for extending all the help for the successful completion of the course and the various organisations for readily sponsoring their candidates as participants. I also thank the faculty members and the participants for their sincere and devoted co-operation but for which this course would not have been a grand success. I would like to place on record my sincere thanks to the other sister organisations in Cochin for extending their help during the training course.

E. G. Silas
Course Director

CONTENTS

I. Inauguration

The inaugural function was presided over by Dr. K. Gopalan. Vice-Chancellor, University of Cochin, Cochin, which was held on 7–11–83, the venue being International Hotel, Ernakulam.

In his welcome address Dr. E.G. Silas, Director, CMFRI and the Course Director of the National Training Course reviewed the present status of the exploited marine fisheries in India mentioning both capture and culture aspects and the role played by CMFRI in the development of marine fisheries research in India. Tracing the history of the fishery science he indicated that from a descriptive science in the last centuary it has now grown to a multi-disciplinary one involving basic sciences such as biology and mathematics, environmental sciences such as oceanography and meteorology and applied sciences such as fish processing, ship building, fishery economics and management. In this era of remote sensing, he continued, the importance of data collection from different angles - biological, environmental and management - and the coverage of EEZ has been felt and CMFRI has established National Marine Living Resources Data Centre to meet the requirements. The system developed by CMFRI in the estimation of marine fish landings in India and the voluminous data collected by CMFRI from its very inception on marine fisheries was also outlined by him. Indicating the increase in the area of exploitation by the declaration of EEZ in 1976, Dr. Silas mentioned that the total marine fish landings in India did not show further increase from 1.4 million tonnes per year, thus belying the expectation of larger landings from the enlarged available area for exploitation. Hence attention has been now drawn, he said, towards diversification of fishing, intensifying coastal aquaculture activities, creating infrastructure facilities and development and improvement of internal and external markets for the marine products. This, according to him, calls for data on the availability of stocks, their levels and the area of their distribution and methods of processing and analysis of the same as quickly as possible so as to make the results available to the industry as and when they are required.

In this context Dr. Silas stressed the importance of such training courses to present before the Scientists the models appropriate for stock assessment. Mentioning

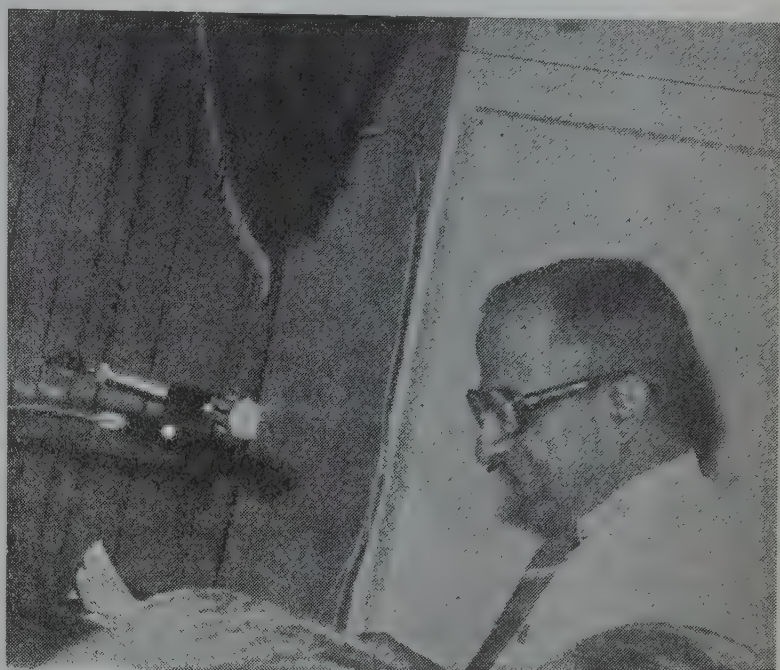
Inauguration

the genesis of this training course, the part played by Mr. Venema and Dr. Christensen and the initial problems encountered, he appreciated the steps taken by FAO and DANIDA in arranging such training courses. Since the four case studies chosen for this training course are concerned with tropicals the participants, he hoped, would be exposed to a number of approaches in dealing with tropical stocks and thus this training course would bring out an evolutionary change in the study of fish stocks in India.

While concluding Dr. Silas expressed his great pleasure in welcoming Dr. K. Gopalan, the Vice-Chancellor of University of Cochin, Mr. S.C. Venema and Dr. J.M. Christensen, the Co-Directors of the Course, Dr. Erik Uısin and other course Instructors, the participants and the distinguished guests including the Press. In his introductory remarks Mr. S.C. Venema, Fisheries Resources Officer, FAO and a Co-Director of this course detailed the genesis of this course and the part played by the FAO. Dr. J. Moller Christensen, Director, Danish Institute for Fisheries and Marine Research, Denmark and a Co-Director of this Course narrated the steps taken by his Institute for the inputs of this Course and wished that more and more exchange of ideas and research results between his Institute and CMFRI would be forthcoming in the future for the betterment of marine fisheries research in Denmark and India.

In his inaugural address, Dr. K. Gopalan, Vice-Chancellor, University of Cochin, expressed his happiness at organising this National Training Course at Cochin and choosing CMFRI as the venue for this purpose. Though he is not a fishery scientist, he mentioned, he is convinced that Indian seas have a high potential of fishery resources. India by declaring the Exclusive Economic Zone in 1976 has extended its national jurisdiction upto 200 nautical miles thus adding a very large area to its economic limits in the sea. This large area, he continued, needs to be intensively explored for the living and the non-living resources. Though fishery potential is estimated at 4.0 million tonnes in Indian waters it has taken three decades to reach a level of 1.4 million tonnes annually in the total marine fish landings in India. In this respect, he commented, the fishing industry is not only very slow to develop but also very reluctant to go in for deep-sea-fishing. The major accent of fishing industry is shrimp-oriented and it has not been easy to wean it away from this "Shrimp-mania". Diversification of fishing over species may help to overcome this. The chartering of foreign vessels by Indian Companies to exploit the EEZ may affect the resources in the inshore waters. Hence the urgency for stock assessment and the appropriateness of this kind of training courses, he added.

While mentioning about the complexity of problems in tropic regions, Dr. Gopalan further said that the marine fisheries in India have peculiar characteristics with over 150 species of fish and shell fish entering the commercial fisheries. The gears operating are varied in nature exploiting different columns of water from surface to bottom. In this context, he pointed out, it is commendable that CMFRI has extensive data on marine fishery resources methodically collected since its inception in 1947 by evolving and later on improving a system of stratified multistage random sampling for this purpose. One can really be proud of this fact that the importance of scientific data collection based on sound statistical principles was realised by India long before any other country in this region. Having sound data base computer facilities are required for quick data processing and analysis. In this context, Dr. Gopalan mentioned, whatever help is required from his University he would like to extend the same to CMFRI. He further added that CMFRI has been recognised by the University of Cochin as the Centre for Advanced Studies in Mariculture for conducting Post Graduate and Ph.D. courses. While concluding he expressed his hope that this training course would help the participants in assessing fish stocks available in EEZ and to make short term forecasts on fish stocks indicating maximum



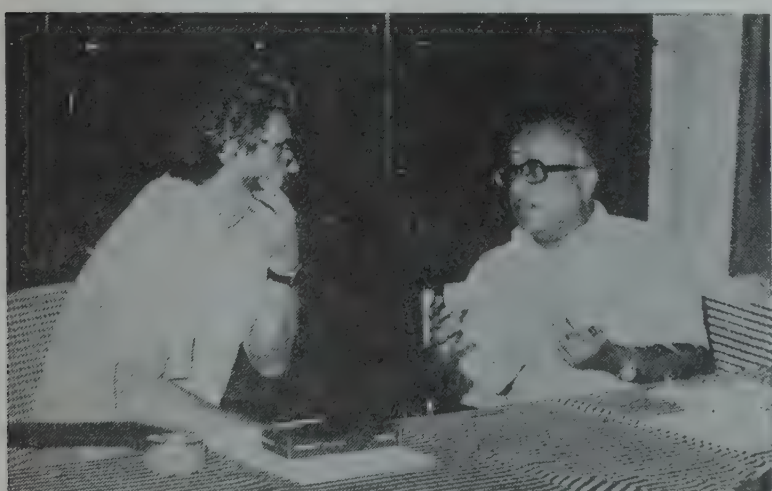
Dr. K. Gopalan, Vice-Chancellor, University of Cochin delivering inaugural address

sustainable yields to the fishing industry and fishery administrators. Wishing success to all concerned he declared the FAO/DANIDA/ICAR National Training Course on Fish Stock Assessment inaugurated.

Shri T. Jacob, Head, Fisheries Economics and Extension Division, CMFRI, Cochin, proposed vote of thanks.

II. Introduction to the Course

The aim of the course is to teach the participants appropriate techniques for assessing fish stocks and fisheries in tropical seas as a basis for management. For this purpose participants are expected to have practical experience in stock assessment and to have a basic knowledge of the standard mathematical methods of fish population dynamics as they are taught at the Central Marine Fisheries Research Institute, Cochin and the Central Institute of Fisheries Education, Bombay. The course commenced with an introduction to mathematics, statistics, calculator programming and some basic concepts. The next four weeks of the course were devoted to four case studies each of a duration of about a week in which one or more important papers or research reports were critically read, calculations checked and alternative methods suggested, tried and discussed. The convenor of each case study saw to it that each method used in the papers read and each alternative method suggested was briefiy high-lighted in a short lecture to make sure that everybody present was familiar with the methods and the ideas behind them.



Course Director Dr. E. G. Silas, Director, CMFRI and Co-Director Mr. S. C. Venema discussing the programme

The first day of each case study was used mainly for review of the basic techniques, general introduction to the subject, discussion on data bases and application to management problems. The last day of each case study was devoted to discussions of the application to Indian research and management. Exercises related to the case studies took place in groups each having an Indian and or an FAO/DANIDA instructor.

During the week days Monday through Friday, work programme started at 08.30 hrs. and concluded at 17.00 hrs. with a lunch break between 12.00 and 14.00 hrs. On each Saturday only morning session was held. In the evenings faculty meetings were held to take stock of what has been presented to the participants on that day and to decide the presentation for the next day. These faculty meetings were found to be very much helpful in that the programme to be presented for the next day was discussed in detail among the faculty members and the mode of presentation was decided so that the participants would feel at home when the methods would be explained. These decisions were based on the experience gained by the staff during their discussions with the participants while working out the exercises during the earlier sessions.

The following lectures on general topics were also arranged during this course.

i. "The tropical, the Temperate and the Arctic Seas as media of fish production".

By Dr. Erik Ursin on 23–11–'83.

ii. "Some recent advances in the study of tropical fish recruitment".

By Dr. Daniel Pauly on 1–12–'83.

Four trips for the benefit of the participants have been arranged as follows:

i. On board the vessel trip on 23–11–'83,

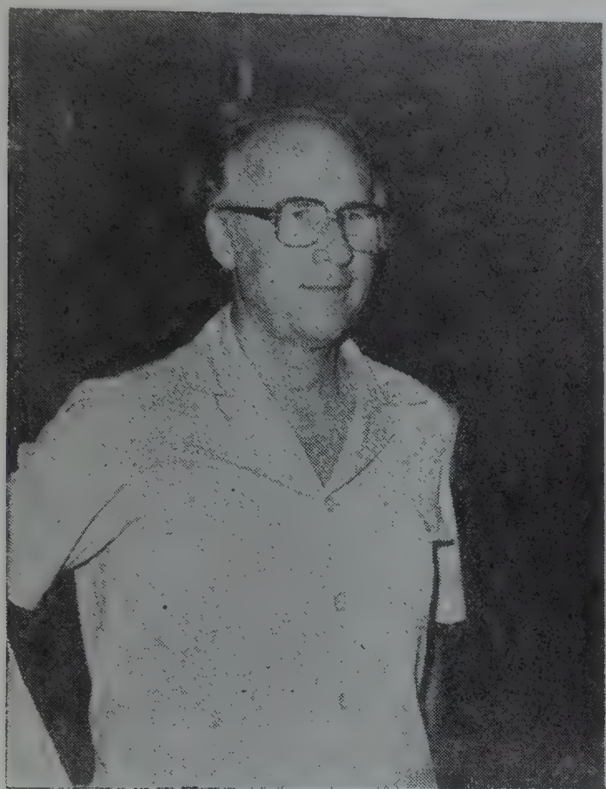
ii. Boat trip to back-waters of Cochin on 27-11-'83,

iii. Visit to Cochin Fisheries Harbour on 3–12–'83 and

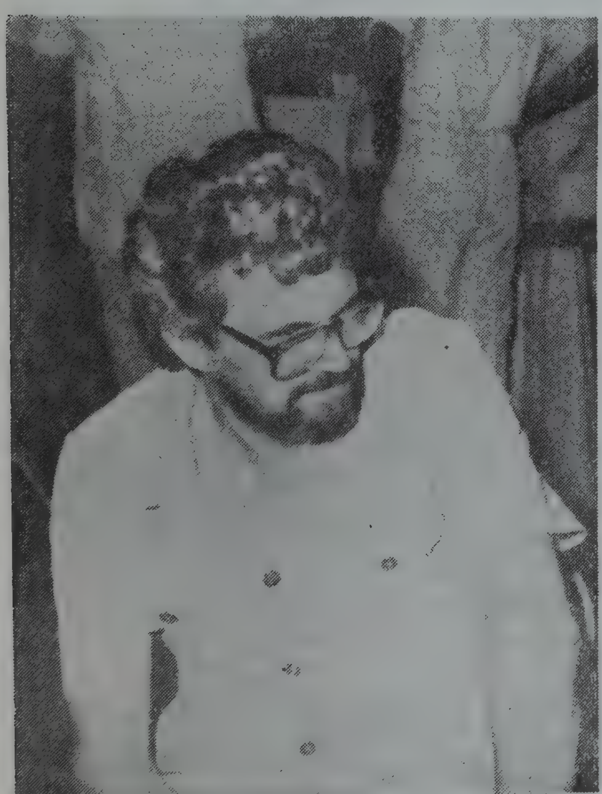
iv Visit to the places of interest-off Cochin on 4-12-'83.

Each participant received a complete set of educational material comprising lecture notes, exercises, extracts of relevant chapters of different manuals,

publications and a scientific programmable calculator, Sharp EL 5100 S (List enclosed, Appendix–3).



Dr. J. M. Christensen Co-Director of the course



Mr. S. C. Venema, Co-Director of the course

The staff of the Course are as under.

Course-Director : Dr. E. G. Silas

Co-Directors i. Dr. J. Moller Christensen (First week only).

ii Mr. S. C. Venema (First and last week)

Course Instructors :

i Dr. Erik Ursin (First three weeks)
ii Mr. Hans Lassen (Last four weeks)
iii Mr. Per Sparre (Last four weeks)
iv Dr. Daniel Pauly (Fourth week only)
v Dr. K. Alagaraja
vi Dr. M. Devaraj
vii Shri K.K. Ghosh.

Course Director and Co-Director with the participants

Dr. J. M. Christensen discussing a point with the scientists

There were two get-together dinners one on 11-11-83 and the other on 8–12–83 in which senior scientists of the CMFRI, Course Director, Co-Directors, faculty members and participants took part.

III. Course Proceedings

Actual training course commenced in the afternoon of 7–11–'83. After self introduction by participants and faculty members Dr. E.G.Silas, the Course-Director expressing his happiness for having this National Training Course at CMFRI explained the facilities, particularly library facilities, available for the faculty members and the participants, at CMFRI. He advised the participants to make the best use of this training course. Dr. J.M. Christensen, then gave a brief talk on the "Role of the Fishery Biologist". While touching upon the historical growth of fishery science he mentioned how the stocks were studied initially and how mathematical models are now used with involvement of various disciplines in studying stocks. Thus he indicated the fishery science has become a multi-disciplinary one involving fishery biology, population dynamics, fishery economics and management. The major events in the fishing history he continued, are (1) tremendous increase in fishing effort and (2) the development of electronic equipments including computers. He also mentioned the principal tasks of a fishery biologist. They are according to him (1) to provide information on the interaction between the production of the fishery resources in the sea (and in fresh water) and the fishery which exploits these resources and (2) to advise administrators about how the fishery affect the resources and hence the yields which may be obtained from them in future. Mr. S. C. Venema briefly described the role of FAO in this training programme on fish stock assessment and the experience gained during the earlier training programme particularly in Kenya.

During the rest of the week refresher courses in Mathematics, Statistics and instruction in the use of programmable pocket calculator Sharp EL-5100 S were given to the participants.

Dr. Alagaraja while introducing the basic mathematics mentioned that Mathematics is a language of symbols. Explaining the same he introduced symbols for summations, product and inequalities. Variables, functions, dimensions, transformations, laws of indices, logarithms, differentiation and integration were the major topics touched up on during this course. Rates of mortality and the difference between ordinary rates and instantaneous rates have also been explained by him. He also distributed his lecture notes on these topics.

Mentioning briefly the importance of Statistics in the study of life sciences Dr. Alagaraja introduced Statistics as a study of variations. Different measures to study a population have also been explained by him under the measures of central tendency and dispersion. Under central tendency mean (Arithmetic, Geometric and Harmonic), median and mode have been explained with suitable examples. Range, mean deviation and standard deviation as the square root of variance were explained by him under measures of dispersion. Lecture notes on these topics prepared by him have been distributed to the participants.

Shri K.K. Ghosh introduced the concept of regression and correlation with simple examples. He also explained the significance of 'a' and 'b', the parameters appearing in the linear regression $y = a + bx$ with suitable graphs. The significance of 'r' the correlation coefficient was pointed by him and lecture notes on these aspects prepared by him have been made available to the participants.

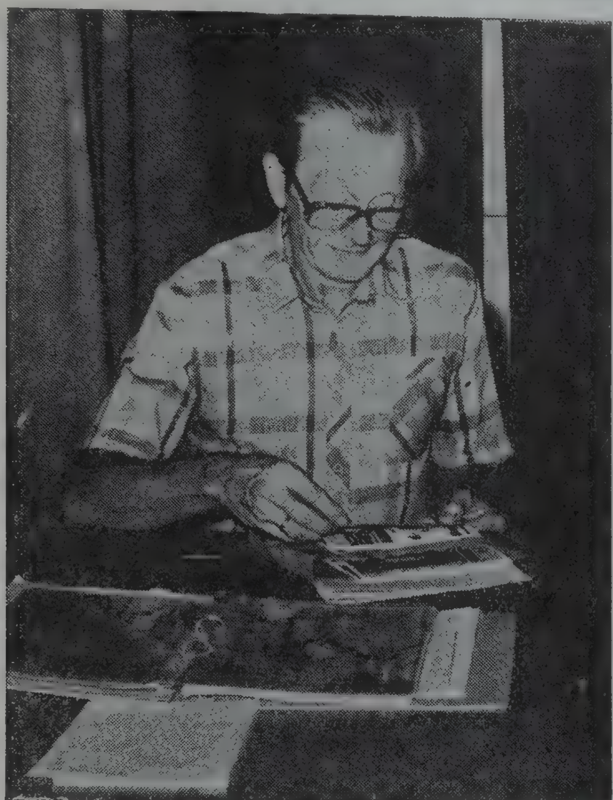
Dr. Erik Ursin introduced the Sharp EL 5100S programmable pocket calculator and explained how basic operations could be performed and simple programmes developed so as to estimate the measures of central tendency, dispersion, 'a', 'b' and 'r'. This introduction was so timed that as soon as a concept was explained and examples given calculation part was done by the help of the calculator. In this way both theory and the method of estimation have been presented side by side for the better understanding of the participants. This approach was very much appreciated by all the participants.

Case Study I: 'Population dynamics of threadfin bream'.

In the second week first case study was taken up by the convenor, Dr. Erik Ursin. The reference material was a paper by Daniel Pauly and P. Martosubroto appeared in 1980 in the Journal of Fishery Biology, **17**: 263–73 the title of the paper being "The population dynamics of a threadfin bream, *Nemipterus marginatus* off Western Kalimantan, South China Sea". Introducing the case study Dr. Ursin mentioned the following.

When handling tropical demersal fisheries with a large number of important species it becomes increasingly clear that some groupings of these fishes are required. Yield assessment can then be carried out for each group of species with similar values of parameters of mortality, growth and food consumption. This requires initial studies of individual species even if these, as in the present case, contribute only one per cent to the total catch. The paper is remarkably suitable for a case study because it highlights many methods dealt with in Pauly's manual, FAO Fisheries Technical Paper No. 24 and takes the

reader through the processes of parameter estimation ending with an yield assessment. It shows how much can be achieved with very limited resources and invites the introduction of several of Pauly's computer programmes.



Dr. Erik Ursin preparing for the case study I

With this introduction Dr. Ursin explaining the case study approach mentioned the importance of critically reading the material to decide whether one should agree with the author(s) or not. He also explained the purposes of data collection in that he highlighted the importance of ageing fish, estimating mortalities and plotting yield curves. For age frequency studies he advocated parabola method which according to him is simple and straight forward when compared to Cassie's and Bhattacharya's methods. He also emphasised the need for alternative methods for estimation of parameters for mutual check.

Participants received a copy of the paper with serial numbers inserted in the margin and referring to a set of notes. These were of three kinds namely (1) comments by Dr. Ursin on methods used and on alternative methods, (2) documentation consisting of copies of relevant pages of papers referred to by authors or papers describing alternative methods and (3) exercises based on data in the paper itself or in the documentation sheets. Participants performed the calculations made by the authors and discussed merits and disadvantages of alternative methods. Opportunity was taken to use the programmable pocket calculator. Additional data were introduced from other publications and incorporated in the study.

During the discussions, participants questioned the way in which mortalities were estimated, moving averages taken and assumptions on isometric growth made by the authors in the case study material. Extensive exercises on decomposition of multimodal curves into unimodal components by using different methods, estimation of mortalities, growth parameters and yield per recruit and use of sharp EL 5100 S in programming the processes to arrive at these estimates easily and quickly helped the participants to understand the stock assessment problems in a very clear way. The importance of the following points has emerged out of this case study.

(1) Representation of the samples—whether the sample is adequate to reflect the characteristics of the stock under study; (2) The periodicity of the length modes —whether it is monthly, quarterly, annual or anything else; (3) assumption on the normality of the components of age distribution and (4) the veracity of the modes— whether the modes are real and age specific or otherwise.

During the session for the presentation of the Indian material Dr. Alagaraja was the Convenor. In this session Dr. Alagaraja, Dr. Sriramachandra Murty, Shri. K. S. Udupa and Dr. Devaraj presented their materials for discussion.

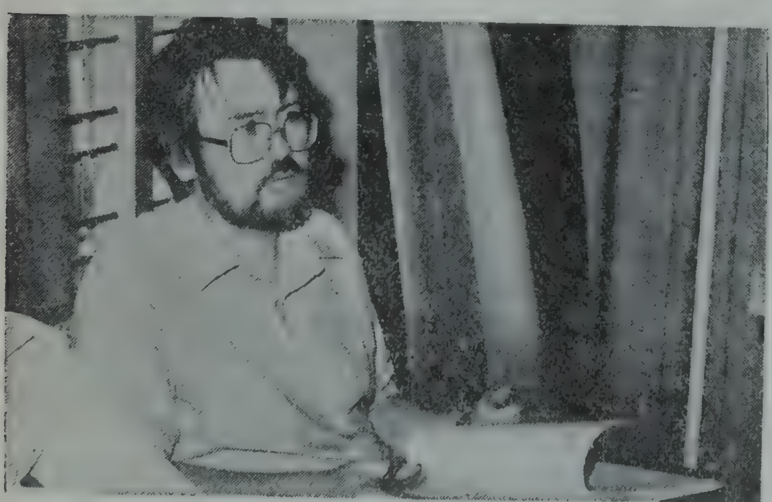
Dr. Alagaraja provided new approach to estimate l_∞ and K along with their standard errors. He brought home to the participants the point that modal progression should not follow either arithmetic or geometric progression when growth is assumed to follow that of von Bertalanffy. Estimating the instantaneous rate of total mortality, 'Z', on the basis of length frequency data alone was also explained by him. Use of data on tagging for estimation of 'K' and assessment of well exploited stocks using theory of relative response were also explained by him with suitable examples. Copies of notes containing these results were distributed to the participants.

Dr. Sriramachandra Murty presented results on *Nemipterus* spp. particularly on *Nemipterus japonicus* in Andhra waters. Explaining the Nemipterus fishery in Kakinada area on the basis of his experience, he mentioned the results obtained by Dr. B. Krishnamurthy. He also mentioned the methods adopted by various authors for estimating growth parameters. He emphasised the need for finding age through hard part studies and doubted whether the modes indicated in Pauly and Martosubroto paper were really annual.

Presenting his material Shri K. S. Udupa explained how to estimate l_∞ and K by using his method of dividing the modes into three equal groups. In case of missing data also he mentioned the method of estimation of l_∞ and K.

Dr. Devaraj, while presenting his material based on the data collected off Bombay coast, mentioned a graphical approach to trace the modes and assigning them age. His approach indicated the existence of two clear broods with six months apart. He was of the opinion that though this graphical approach is subjective this may indicate atleast the relative age of modes. Regarding the adjacent modes these modes may belong to males and females which exhibit differential growth. He suggested that such modes could be separated on the basis of sexes and graphs for males and females could be drawn. However, he pointed out that sexing in their earlier stages of growth would not be easy.

Winding up the discussions the convenor Dr. Alagaraja thanked Dr. Ursin for the interesting way he conducted the case study and Dr. Devaraj, Shri K. S. Udupa and Dr. Sriramachandra Murty for presenting Indian material.



Mr. Per Sparre with material for case study II

Case Study II. "Assessment of penaeid shrimp stocks"

During the third week second case study was taken up by Mr. Per Sparre, the Convenor. The topic was the assessment of penaeid shrimp stocks. The material for this case study was based on the paper entitled "Estimation of mortality rates and population size for shrimps in Kuwait waters"– Kuwait Bulletin of Marine Research 1981 by Jones and Van Zalinge.

In Kuwait, when processed, shrimp tails are usually graded into about ten size groups. Data on the quantities processed on each size category are used to estimate length composition of shrimp landings. These data formed the input to the case study material considered here for "Jones" length cohort analysis which as output gave monthly estimates of mortality rates and stock sizes. This method was illustrated by the data from Kuwait shrimp fishery. The results from the cohort analysis were compared to those obtained from an alternative method namely the cumulative catch curve method. This case study dealt with the data on shrimp tails as mentioned earlier. Data on shrimp tails are not difficult to obtain. The conversion of data on shrimp tails to the length data is also straight forward. Hence the importance of this case study to obtain information from industrial data.

In his introductory remarks on the case study Mr. Sparre explained four different methods for assessing shrimp stocks viz (1) cumulative catch curve; (2) Beverton-Holt method of estimation of 'Z' using mean size and the size at first capture; (3) cohort analysis using age frequency data and (4) cohort analysis using length frequency data. He added that in the cumulative catch curve a constant 'Z' is assumed and so also in the Beverton-Holt approach. In the case of cohort analysis natural mortality alone is assumed to be constant. Hence 'F' the instantaneous rate of fishing mortality becomes age or length specific in this case. Virtual population analysis (VPA) developed by Pope has been extensively used for this purpose. Programmes using the Sharp EL 5100 S for cohort analysis and cumulative catch against length and age were given to the participants. Methods of arriving at the results step by step in each of these approaches have been illustrated in the work sheets supplied to them. Extensive exercises were given and by doing these exercises the participants became familiar with these methods.

During the discussions it was pointed out that the cumulative catch approach using relative age using von-Bertalanffy's growth equation was more time consuming than the one where lengths were used in the place of estimated relative age on the basis of lengths. The difference in the estimates of Z for males and females was explained by the phenomena that segregation of males and females takes place during breeding season when females move to deeper areas for spawning. While clarifying the doubts Mr. Sparre mentioned that in cohort analysis internal consistency in the estimates of 'F' should be ensured. For deciding the magnitude of 'M' the instantaneous rate of natural mortality, the range of M/K should be taken into consideration. The initial value of 'F' substituted in the cohort analysis should be such that the curve of 'F' against length groups is almost

asymptotic at larger lengths. Shri K.K. Ghosh, by bringing out the contrasts between the different methods, clarified the doubts of the participants.

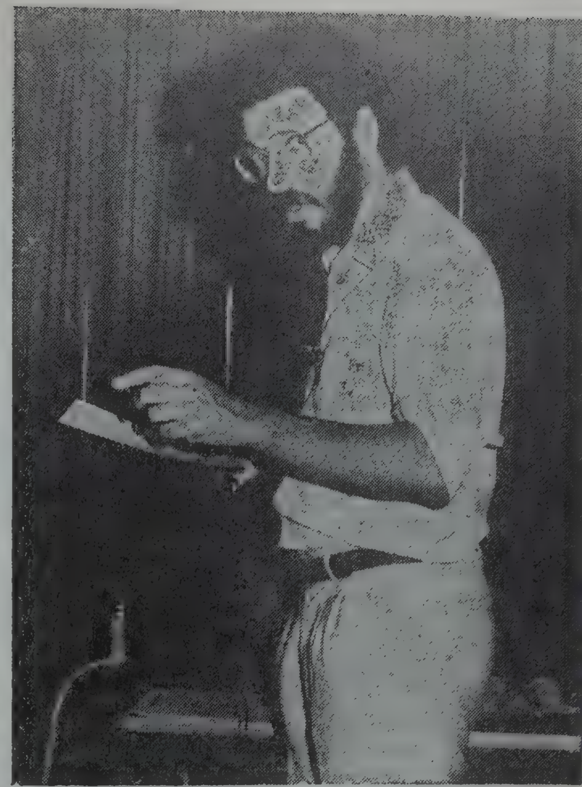
Dr. M. Devaraj was the Convenor when the Indian material was presented under this case study. Dr. S. Ramamurthy and Dr. Devaraj provided the material for discussions.

While enumerating constraints on shrimp stock assessment studies Dr. Ramamurthy highlighted the persistence of modes throughout the year, clearly indicating the breeding of shrimps over a wide range of time. He presented the estimates of growth parameters as arrived at by him and other workers for detailed discussions. He also pointed out the difficulty in arriving at these estimates as the shrimp fishery is a multi-species one operated upon by multi-gears. Standardisation of effort posed problems he added.

Continuing the presentation of the Indian material Dr. Devaraj compared the estimates of growth parameters for *Metapenaeus dobsoni* as arrived at by different workers on the basis of data collected at Cochin, Calicut, and Mangalore. Comparing the estimates he explained the reasons for differences if any among them. During the discussions it was mentioned that identification of age groups was the problem in assessing shrimp stocks. Winding up the discussions, Dr. Devaraj thanked Mr. Sparre for the clarity of his presentation of the case study and Dr. Ramamurthy for his contribution in the session for the presentation of Indian material.

Case Study III "Small-scale fisheries of San Miguel Bay"

Dr. Daniel Pauly, as the Convenor for this case study in the fourth week, presented the material "Small-scale fisheries of San Miguel Bay, Philippines", ICLARM, Technical reports Nos. 7 to 10. He started his case study in the form of questionnaire for formulation of management advice based on data from the multi-species, multi-gear and multi-problem fishery of San Miguel Bay. For this purpose, according to him, formulation of management advice must be based on a broad understanding of a fishery inclusive of the social and economic factors affecting the fishery. This applies particularly to such cases where conflicts between small-scale and large-scale fishermen augment the usual problems associated with the assessment of any tropical fishery. This case study was based on the results obtained in the course of the multi-disciplinary investigation of a major fishing ground in the Philippines, the San Miguel Bay. Information relating to the following aspects of the fishery was presented and discussed by the participants. The major aspects



Dr. Daniel Pauly driving home a point

were the bay ecosystem, estimation of catch and effort, stock assessment, fishery regulations and legal aspects, economics of production and marketing, incomes, assets and attitudes in fishermen families, their occupational and geographical mobility and alternative occupations, rich and poor fishermen the problem of equity vs economic-efficiency, estimating maximum economic yield (MEY) and MEY as a basis for fishery management.

The available information was then used by the participants to formulate realistic management schemes for the San Miguel Bay fishery. These management schemes considered all forms of interventions possible to various agencies, including but not restricted to direct interventions (quotas, control of effort, closed seasons etc.) as well as indirect ones (helping to set up production of marketing co-operatives, subsidies, cheap loans, infrastructure development etc.). Thus the major aim of this case study is to provide the participants with criteria with which to assess the usefulness of various methods and approaches used in stock assessment and to formulate meaningful fishery research programmes.

Since the approach in this case study was different from the earlier ones in that the present case study did not require much routine calculations but more thinking and formulations of research programmes including budget proposals, the participants felt a change for the good and were enthusiastic in advancing their ideas in different aspects of management planning. Each group was asked to develop a programme for a better management of a fishery and a representative of each group

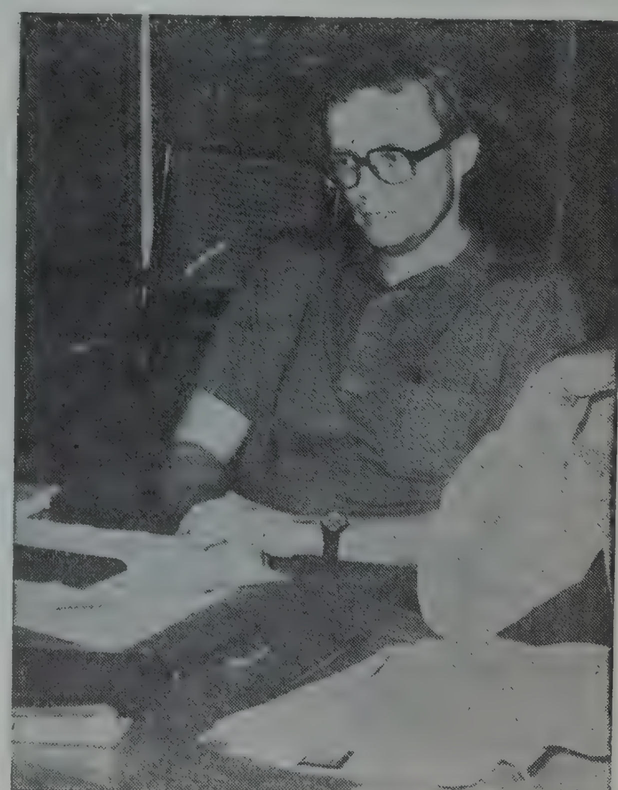
was asked to come forward to present his group's ideas. After the presentation of ideas by all groups, discussions took place and the omissions and commissions in the project so developed and improvements required to meet all the challenges – social, political and economical – have been spelled out. Dr. Pauly maintained that in studying various aspects of fishery one should take note of question of sequence, relevance of factors, abiotic factors affecting fishermen and choice among priorities for detailed study.

In continuation of this case study, Mr. Hans Lassen gave a brief account on fishery economics covering biology, economy, sociology and laws of fishing. He also introduced the concept of 'opportunity cost'. In the place of maximum sustainable yield (MSY) which deals with biological aspects of fishery only, he mentioned, maximum economic yield (MEY) is to be taken into account since this concept covers both biological and economic aspects of a fishery. During the discussions it was pointed out that maximum catch, maximum income and maximum employment would not be compatible and hence a suitable course has to be considered to take care of socio-economic aspects while making policies in fishery development programmes. The importance of three tier planning namely structural, functional and practical was also brought out during the discussions. Winding up the case study Dr. Pauly brought out the significance of old data and advantages of comparative study using different models on data bases collected at different periods.

While the Indian material was presented by Shri. K.K.P. Panikkar, Shri. K. K. Ghosh was the Convenor. Dealing with the impact of purse-seining on indigenous fishing in Kerala coast Shri. Panikkar mentioned that though the catch levels of mackerel were not affected much, the reasons for lesser landings of mackerel by the indigenous units were the earlier arrivals of mackerel of purse-seines through trucks throughout the coast and the lower price of fish. Since the price per kg. of mackerel was low indigenous units stopped going for mackerel fishing during 1981. He also pointed out that indigenous fishermen sought alternative employment as road repairers, stone cutters etc. during this period. He then presented data on the compatibility of mechanised fishing with the indigenous fishing. The area of study for this purpose was Pudiappa-Puthiangadi near Calicut. In this area near about sixty mechanised boats were introduced by the Agricultural Refinance Development Corporation, through the fishermen Co-operative Societies involving many of the fishermen families and hence fishermen using indigenous units started operating mechanised boats also. These fishermen during off-season used mechanised boats for towing indigenous units to deeper waters and started fishing. In this way, Shri. Panikkar pointed out, the availability of mechanised boats was fully utilised by the local fishermen along with their indigenous units for increasing their income from fishing. Analysis of data further indicated more economic activity in this region when compared to the nearby village Elathur. During the discussion it was pointed out that over capitalisation should not be encouraged and for this purpose stock assessment studies of the region should be taken up before enlarging the effort of fishing. Winding up the discussion Shri Ghosh thanked Dr. Pauly for his innovative approach in the case study and Shri Panikkar for having presented Indian material for discussion. He appreciated the work done in this line and wished that more and more such studies would be taken up in order to understand the fishery as a whole and the impact of the changes taking place in the fishery on the socio-economic conditions of the fishermen community.

Case study IV: "Appraisal of data from research vessel survey".

In the fifth and the final week appraisal of data from research vessel survey was taken up for the fourth case study. The material for this purpose was drawn from the survey report from Kenya. Mr. Hans Lassen was the Convenor for this case study. According to him, assessment of tropical fish stocks is often mainly based on results from research vessel surveys. These surveys



Planning for presentation of material for the case study IV-
Mr. Hans Lassen

may be based both on trawling and on acoustical integration. Both methods create a large confusing pile of work sheets. The case study illustrates the process from work sheet to condensed tables in a report. The problem also exists for other sampling programmes and the principles illustrated in this case study apply equally well to that situation. The objective of surveying is an appraisal of the fish resources and an evaluation of the possible yield which may be expected from the surveyed stocks.

The exercises in this case study hence centred on estimation of stock abundance from a set of trawl hauls and acoustical transects. The statistical back ground, sampling design, estimators etc were presented without any formal mathematical derivation of formula. The data reduction required in these types of analysis was demonstrated by design of worksheets. The participants received relevant extracts of the reference listed above and related exercises.

To assess fish stocks, Mr. Lassen continued, information on the following items should be obtained: (1) gear-wise catch per unit effort; (2) area swept-out by each gear; (3) average biomass; (4) species-wise catch details and (5) efficiency of each gear. With the knowledge of these items one would be able to pool the estimates to obtain MSY and test the precision of estimates. To explain basic concept of sampling techniques to the participants he requested Dr. Alagaraja to give a talk on this topic. He also requested Shri. Ghosh to explain the participants the basic concepts of analysis of variance (ANOVA) as required in the case study.

Accordingly Dr. Alagaraja mentioned the importance of sampling, difference between sampling and census and the preference for sampling over census. While explaining the different sampling techniques he touched upon simple random sampling with and without replacement, systematic, cluster and stratified sampling and multi-stage sampling. He also briefly mentioned the methodology used by CMFRI for estimating marine fish landings in India through a stratified multistage random sampling scheme. Lecture notes prepared by him on these aspects were distributed to the participants.

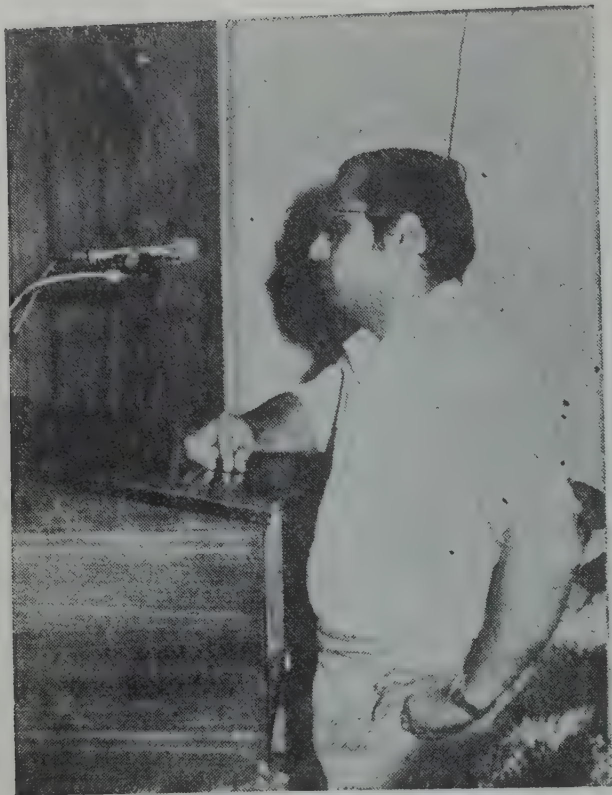
Shri K.K. Ghosh explained the use of ANOVA and mentioned the important assumptions underlying the models. One-way and two-way classifications under ANOVA have been presented and the significance of each term was pointed out. The lecture notes containing these aspects have been distributed by Shri Ghosh to the participants.

Continuing the case study Mr. Lassen explained the three methods of estimation of potential yield (P.Y.) In all these methods, an estimate of biomass (B) is required. The first method equates P. Y. with 0.5 x M x B., where M is the instantaneous rate of natural mortality. In the second method M is replaced by Z the instantaneous rate of total mortality. In the last method P.Y.= 2.3 x W x B. This case study was also full of exercises and once again the participants started using pocket calculators vigorously. The use of transformation of data when some of the assumptions for ANOVA were not true was explained by him. Logarithmic transformation, he suggested, would be better for the data obtained from trawl surveys.

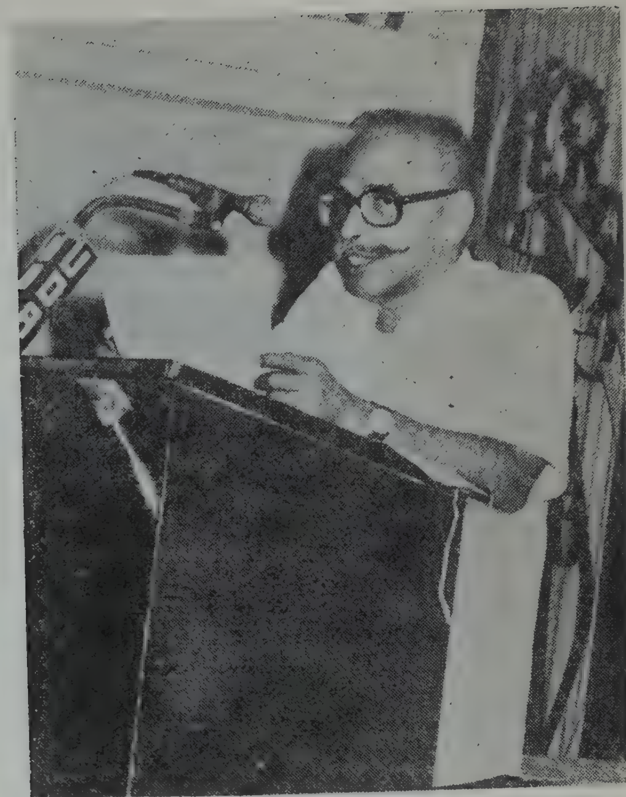
Dr. Devaraj was the Convenor when the Indian material was presented by S/Shri. K. Krishna Rao and M.E. John. Shri Rao explained the method of forming grids for surveys and mentioned two approaches of surveys viz. parallel grid and zig zag grid surveys. Copies of his paper containing the results of his findings have been distributed. Shri. John placed before the participants the results of a cruise in which he was the leader. In this cruise he mentioned that there were 85 trawl stations. The duration of the cruise was 22 days. Each haul covered two hours. The total catch was about 24 tonnes dominated by cat fish forming about 50%. On the basis of this survey depthwise species availability could be indicated, he mentioned. Since this survey was meant for fish trawling, the catches did not contain shrimps.

Winding up the discussions Dr. Devaraj thanked Mr. Lassen for his lucid way of presenting his case study and the extensive exercises. He also thanked S/Shri. Krishna Rao and John for presenting the Indian material and the participants for their involvement in the discussions.

During this week, a questionnaire prepared by Mr. S.C. Venema was distributed to the participants to assess their impressions on this training course. It revealed that those who have mathematical/statistical background have expressed that the course content is sufficient in this topic. Those who have no background however indicated that the duration may be extended from one to two weeks, increasing exercises both in mathematics and statistics. There was an overall agreement in expressing their appreciation to Dr. Erik Ursin's way of presentation of case study, and all the participants felt satisfied in the way the discussions were held throwing much light on the stock assessment. It was also expressed that the exercises in the second case study by Mr. Per Sparre were informative and exhaustive. The



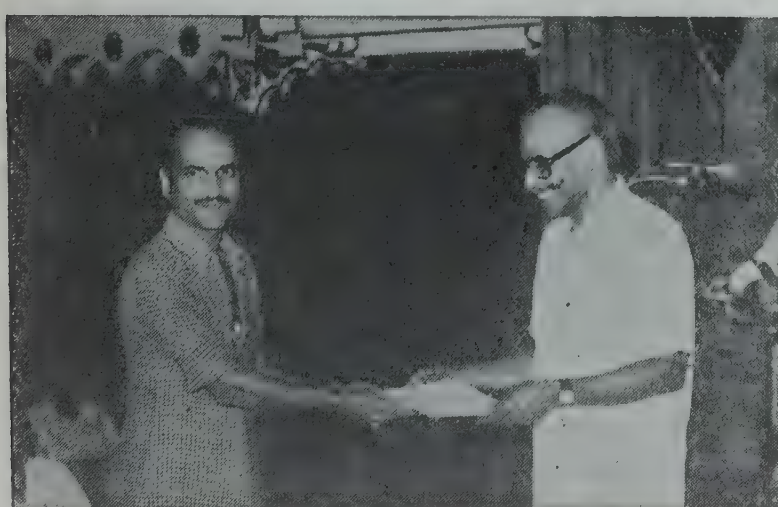
Shri K. S. Udupa giving his impressions



Shri T. Madhava Menon, Vice-Chancellor, Kerala Agricultural University, delivering the valedictory address

Distribution of certificate

Distribution of certificate



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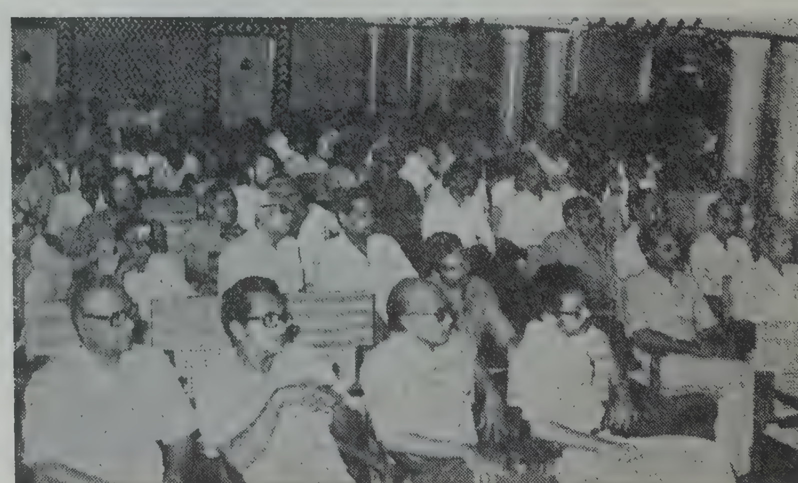
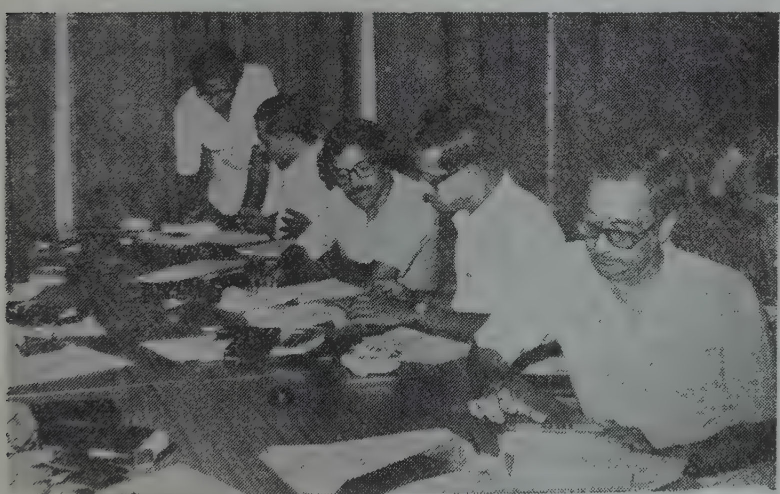


A view of the audience

relevance of the third case study by Dr. Daniel Pauly was very much appreciated and also the case study on trawl surveys by Mr. Hans Lassen.

IV. Valedictory function

On 9–12–83 the final day of the course, valedictory function was held at 16.00 hrs at the Banquet Hall of International Hotel, Ernakulam. Shri. T. Madhava Menon, Vice-Chancellor of Kerala Agricultural University presided over the function. Dr. K. Alagaraja welcomed the gathering. Dr. E.G. Silas in his introductory remarks expressed his happiness for the successful completion of the training course and hoped that the benefit accrued from this course to the participants would be reflected in their research programmes on stock assessment and in the re-orientation of syllabus in their teaching programmes on this topic. He also mentioned that CMFRI would extend all required help to the participants in this regard. Mr. S.C. Venema expressed his thanks on behalf of FAO to one and all for the happy ending of the training course and appreciated the systematic way the daily programmes were conducted and the regularity and punctuality in the attendance of the participants. He also mentioned that he has gained a lot from this course by his participation in the discussions during the course. He wished that follow up action would be taken up by all concerned by keeping up contacts with one another.



Participants at work

Impressions on the course were given by Shri. K.K. Ghosh from the faculty side and by Dr. S. Ajmal Khan and Shri K.S.Udupa from the participants side. They all expressed their happiness for taking part in this course and thanked the Course Director for arranging this training course. They also thanked FAO, DANIDA and ICAR for the same. They mentioned that they would take up their work in stock assessment with new ideas derived from this course and reorient their teaching course accordingly.

Shri T. Madhava Menon gave the valedictory address and distributed the certificates to the participants.

In his valedictory address Shri. Madhava Menon expressed his thanks to Dr. E.G. Silas, Director, CMFRI for inviting him to preside over this function and to distribute the certificates to the participants. In the course of his address he commended the role played by FAO and DANIDA for organising this type of training on global level. Tracing the history of fishing from the time immemorial to the present day he said that fishing has remained a family occupation in our country. The improvement in the marine fish landings from a humble 0.5 million tonnes in fifties to about 1.4 million tonnes at present, he opined, was mainly due to R & D programmes in this sector after independence and these programmes have lifted this artisanal occupation to a highly capital intensive industry earning at present a foriegn exchange of about Rs. 350 crores.

While comparing fish stocks with other resources he mentioned that these stocks are beyond direct count and there are innumerable number of species spread over the seas in a heterogeneous way due to different environmental conditions such as depth, current, temperature, wind and latitude. Moreover the marine wealth is not inexhaustive as it was thought of, he said. To support this he cited the anchovian fishery of South America. In this context he stressed the need for a good data base and quick processing and analysing through computerised approach.

Shri Madhava Menon expressed his happiness for the selection of suitable case studies for this course. Indicating their relevance for our conditions he mentioned that methods developed elsewhere and quoted in these case studies should both be a challenge and a hopeful solution to our Scientists and Administrators. Appreciating the appropriateness of the choice of Central Marine Fisheries Research Institute, Cochin as the venue for this National Training Course he also mentioned the important role played by CMFRI from its very inception in the field of marine fisheries research, the system of data acquisition developed by it, the establishment of National Marine Living Resources Data Centre at this Institute and short and long-term multidisciplinary research programmes on capture and culture fisheries undertaken by it.

Commending on the choice of expertise from FAO, DANIDA and ICAR Institutes and the selection of

participants from various Universities, Research Institutes and Fisheries Organisations and the subject chosen for this course he expressed his great pleasure in wishing every success to one and all concerned in transforming the ideas developed during the training course to the practice of fishery management and for the benefit of all in this country.

The function formally came to a close with proposing vote of thanks by Dr. M. Devaraj.

V. Special lectures

There were two special lectures arranged for the benefit of the participants and other Scientists working in CMFRI and other fishery organisations in and around Cochin. In this connection invitations have been sent to all Fisheries Research Institutes, State and Central Fisheries Organisations and the Universities. These lectures weie well-attended by the staff of these institutions.

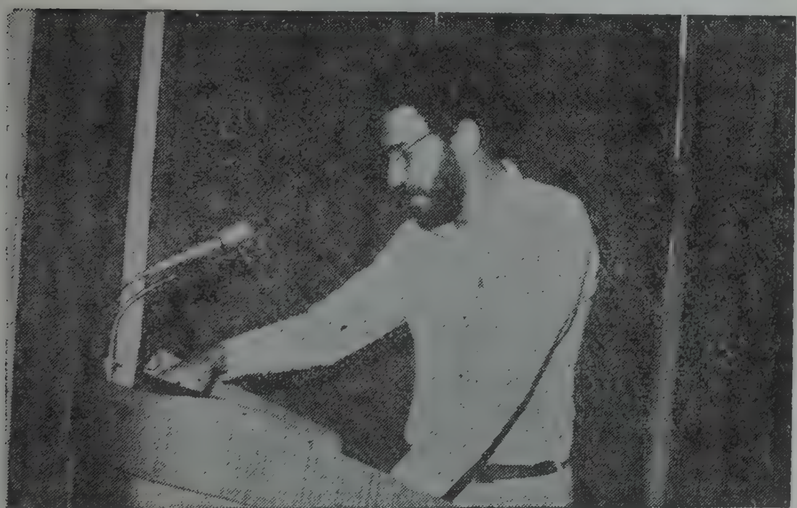
Dr. Erik Ursin delivering special lecture

The first lecture on "The tropical, the temperate and the Arctic seas as media of fish production" was delivered by Dr. Erik Ursin on 23–11–83. In that he highlighted the differences of conditions of marine life in high and low latitudes. According to him the three major causes for the differences are (1) the more marked seasonal differences in high latitudes; (2) the differences in metabolic rates and rates of decay caused by temperature; and (3) the specialisation achieved in evolutionary old echo-systems. Explaining the range in temperatures prevailing in these regions he drew the attention of the audience to the relationship existing between phytoplankton and copepods and between copepods and predators. He also mentioned about the seasonal variation in primary production. He further observed that temperate seas with mean temperature about 10°C and an annual variation in temperature from 3°C to 16°C are similar in many ways to the Arctic seas. However, when in Arctic seas we have an annual primary production of 40 g $C/m^2/y$, we often have 100–200g in temperate waters. By contrast the tropical shelves proper, with temperatures about 27°C all the year around usually show little seasonal variation in primary production. The great difference is between the open sea with low production rates of 40g $c/m^2/y$ as in the Arctic and the coastal waters with production levels of 200–400 g. The absence of time lags between biomass maxima of the different trophic levels is found in the tropic seas.

Regarding metabolism, Dr. Ursin explained, that it is also related to temperatuie and indicated how the growth parameters l_∞ and K are dependent on metabolism. The tropical fishes generally appear to have, according to him, a routine metabolism two or three times higher than fishes of cold temperate waters. Geologically, he continued, the Pacific is supposed to be the oldest sea with the highest number of species. In contrast the cold temperate and the Arctic seas are extremely young regions on which so many stock assessment studies have been made. In these regions there has been little time for evolutionary adaptation and most species may be called ubiquists as compared to the varied and highly specialised fauna of the tropical Pacific and the Indian Ocean. The ability of an echo-system to withstand the effects of major fishery seems related to its specialisation; the more specialised, the more vulnerable. The North Sea is an example of a particularly robust system. In spite of a massive reduction of the stocks of herring and mackerel as an effect of introducing new technology the total fish biomass remained almost

the same. While concluding Dr. Ursin mentioned two important differences of tropical and temperate fish stocks viz. (1) The maximum of the yield curve (if any) is reached at higher effort levels in tropics. The kind of overfishing experienced at effort levels higher than 'Fmax' giving maximum yield is not likely to be discerned in a multi-species tropical fishery; and (2) temperate seas are characterised by relatively high virgin biomass because of the lower natural mortality rates which permit more age groups to contribute to the biomass.

The second lecture was given by Dr. Daniel Pauly on 1–12–83. The topic was "Some recent advances in the study of tropical fish recruitment". Recalling the failures of anchovy fishery in Peruvian waters and herring fishery in the North Sea he surmised that this failure could be due to lack of abundance in the recruitment to the exploited stocks. Hence, the relevance of study on recruitment in his opinion, assumes greater importance in assessing the exploited fish stocks. Reviewing the earlier work on this aspect he mentioned that different



Dr. Daniel Pauly delivering special lecture

types of relationships have been indicated between recruitment and stock size by different workers. Cushing tried to match spawning and Zooplankton production. Recruitment curves developed by Ricker and later by Beverton-Holt related recruitment with parent stock. Continuing Dr. Pauly said that there are many other factors that determine the recruitment to the stock. Environmental factors affecting (1) parent stock at the time of spawning; (2) eggs after spawning; (3) larvae before recruitment to the fishery; and (4) availability of food for recruits should be taken into account for establishing the failure or success of the fishery. This in turn helps one to evaluate maximum sustainable yield (MSY). The earlier models of Ricker and others are simplified versions of the conditions obtaining in nature. These simple models do not take into consideration the environmental factors since equilibrium conditions are assumed for these models. Hence the need to integrate all these items in a model if it is to be realistic, he asserted.

Some of the most important factors that effect recruitment are upwelling, turbulence, monsoons, water and wind currents. Dr. Pauly illustrated the relationship between the effect of turbulence on the availiability of food and the mortality of the larvae. He also indicated that turbulence is proportional to the cube of wind force. Effect of monsoons on spawning success is well established, he pointed out. The importance of microlayers for better recruitment is felt now-a-days. Apart from these environmental factors predators play a vital role on recruitment. In the light of this, Dr. Pauly suggested for a multifactor model involving environmental factors, predators, etc. in the place of existing simple models. The model he presented was

$$\log R/S = a + S + \sum_{i=1}^{n} b_i xi$$

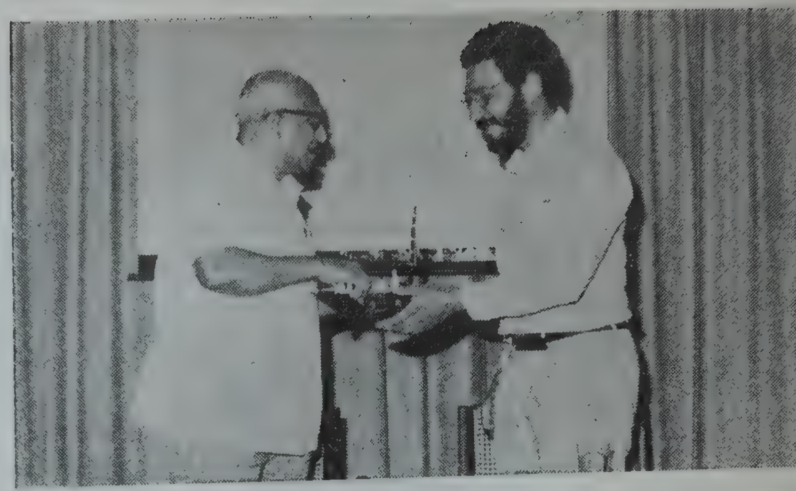
Where R and S indicate recruitment and Stock size respectively and x_i indicate factors such as predators, temperature and turbulence. He mentioned that data collected over thirty years on about twenty factors have been considered for analysis. He concluded saying that this multimodel approach would certainly lead to better understanding of recruitment pattern and reliable prediction on yield.

VI. Outings

One vessel trip on 23–11–83 was arranged with the help of CIFNET for on board the vessel "Blue fin" for the benefit of the participants. Uses of acoustic equipments sonar and echo-sounders have been explained to them. Fish trawling was conducted off Cochin and the presence of Mr. Hans Lassen, the Convenor of the last case study on "Appraisal of data from research vessel survey" benefited one and all.

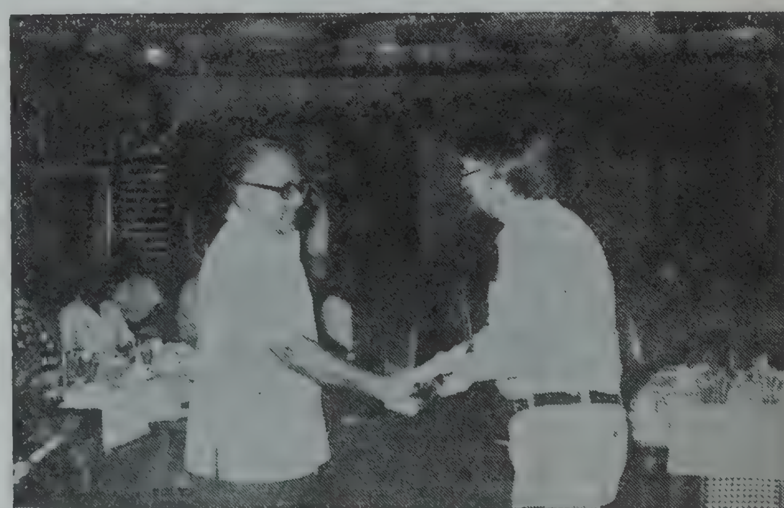
Another boat trip visiting Fort Cochin, Mattanchery and nearby islands on 27–11–83 was arranged. The operation of Chinese dip-nets and identification of species caught in these operations have been explained to the participants. St. Francis Church at Fort Cochin where Vasco-da-Gama was once buried, Dutch Palace and Jewish Synogogue at Mattanchery were the other places of interest visited by the participants.

Mr. S. C. Venema receiving memento from Dr. E. G. Silas

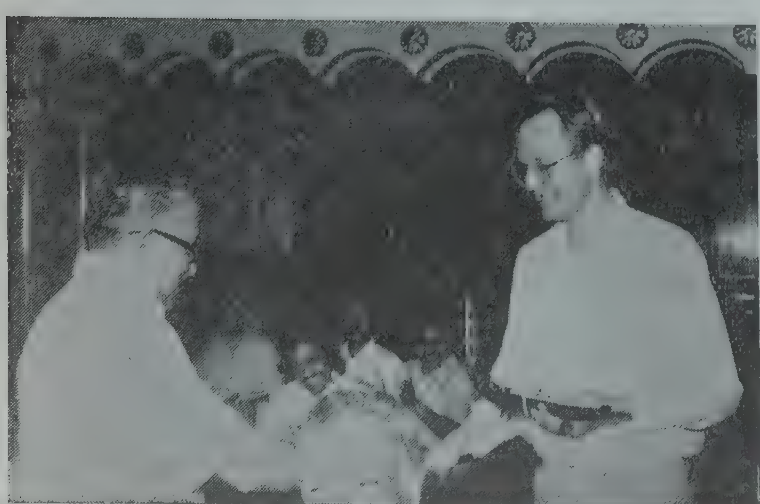


Dr. Daniel Pauly receiving memento from Dr. S. V. Bapat, Joint Director, CMFRI

Dr. Erik Ursin receiving memento from Dr. S. V. Bapat



Mr. Per Sparre receiving memento from Dr. E. G. Silas



Mr. Hans Lassen receiving memento from Dr. E. G. Silas

Dr. Erik Ursin with scientists at get-together

Get together talk by Dr. E. G. Silas

Get together

In order to see the gill net landings at Cochin Fisheries Harbour and assess the daily total landings, a trip was arranged on 3–12–83. Early morning at 06.30 hrs gill nets started arriving with their catches. The participants could get a very good idea about the pattern of landings. The procedure of collection of catch and other details including the species composition and collection of biological data done by CMFRI was explained to the participants.

Get together entertainment

On 4–12–83 the participants and faculty members went out of Cochin to see some of the important places of interest such as Kaladi and Edamalayar dam This trip was so refreshing in that everyone could enjoy the scenic beauty of Kerala and breath fresh air in the hilly regions. The weather was also fine throughout the day as if prearranged as exclaimed by Mr. S. C. Venema, one of the Co-Directors of the Course.

VII. Lighter Moments

Chinese dip nets:

When the participants and the faculty members reached Fort Cochin they were shown the operation of Chinese dip nets. At that time an over enthusiastic person shot his collegue with the question: Do you know Chinese dip nets? Pat came the reply: Why? Everybody else does the same I suppose.

Blindmen and the elephant:

While discussing about the various models for assessment of fish stocks a question was raised about the reliability of models. The answer was given with a simple story of blind men assessing an elephant by touching its different parts. One man touches its trunk, second its tail, third its leg, fourth its body, fifth its ear and so on. Each gives his description of the elephant. In fact each of their description of the elephant so far as its particular part is concerned is true. However, their descriptions differ so widely that for a person who has not seen an elephant these findings are very much confusing and as a result of this he does not believe these descriptions. Similarly no model that exists at present is capable of describing fully the conditions of an exploited stock. More and more information is required to understand the stocks better. In fact fishery independent factors do not have a role in the present day models.

Herring is lost:

There was a discussion on depletion of stocks particularly of herrings of the North Sea. Many reasons were advanced by the participants and faculty members for this depletion. In this connection an anecdote on

an ICES (Internation Commission For The Exploration of Seas) meeting on herring depletion was mentioned. A Scientist was coming out of the ICES Conference and excitedly mentioned to his collegue "Herring is lost". "Herring is Lost". An onlooker, surprised at this remark went near the Scientist and patting on his shoulder remarked that her ring was intact and it was not lost. The surprised Scientist looked at the onlooker and then at the direction shown by him. There Mrs. Scientist with her earrings intact was slowly following him. This anecdote is meant to bring home the fact that even the most affected stocks once left to themselves and ensured protection will not actually be lost and the renewable characteristic of this living resource will be reflected in the reapperance of the stocks.

Carp, Shark and Ray:

The result of this training course is that hereafter there may be no carping on that there are sharks in solving some of the problems on tropical fish stocks as there is a ray of hope in solving the same.

Faculty members and participants

Sitting (L to R) K. Alagaraja, P. Sparre, H. Lassen, Erik Ursin, E. G. Silas, Daniel Pauly, K. K. Ghosh, M. Devaraj.
Standing 1st row (L to R) K. Krishna Rao, K. Narayana Kurup, M. Srinath, R. Thiagarajan, V. Sriramachandra Murty, R. A. Gupta, T. M. Yohannan, D. K. Chowdhury, S. Ramamurthy, K. V. Narayana Rao, M. E. John, C. Mukundan, K. Gopalakrishnan, K. Y. Mohammed Salih.
Standing 2nd row (L to R) R. K. Tyagi, K. K. P. Panikkar, R. S. Biradar, P. Natarajan, P. M. Mitra, M. M. Meiyappan, C. Suseelan, T. M. Sankaran, P. Parameswaran Pillai, S. Ajmal Khan and K. S. Udupa.

VIII. APPENDIX

Faculty members

Dr. E. G. Silas,
Director,
Central Marine Fisheries Research Institute,
Cochin - 18
Course Director

Mr. S. C. Venema,
Fishery Resources Officer,
FAO, Rome
Course Co-Director

Dr. J. Moller Christensen,
Director,
Danish Institute for Fisheries & Marine Research,
Denmark
Course Co-Director.

Dr. Erik Ursin,
Danish Institute for Fisheries & Marine Research,
Denmark.

Mr. H. Lassen,
Danish Institute for Fisheries & Marine Research,
Denmark.

MR. P. SPARRE,
Danish Institute for Fisheries & Marine Research,
Denmark.

DR. D. PAULY,
International Centre for Living-
Aquatic Resources Management,
Manila, Philippines.

DR. K. ALAGARAJA,
Scientist S-2,
Central Marine Fisheries Research Institute,
Cochin - 682 018.

DR. M. DEVARAJ,
Scientist S-2
Central Institute of Fisheries Education,
Jaiprakash Road, Andheri (West)
Bombay - 400 058.

MR. K. K. GHOSH,
Scientist S-2
Central Inland Fisheries Research Institute,
Dhauli, Kausalyaganj P. O.,
Via Bubhaneshwar - 751 002.

Appendix II

Participants

1. DR. S. AJMAL KHAN,
Centre of Advanced Studies in Marine Biology,
Parangipettai–608 502.

2. SHRI. R.S.BIRADAR,
Scientist S–2,
Central Institute of Fisheries Education,
Bombay–400 058.

3. SHRI. D.K. CHOWDHURY,
Central Institute of Fisheries Education,
Bombay–400 058.

4. Shri R. A. GUPTA,
Central Inland Fisheries Research Institute,
Allahabad – 211 002.

5. SHRI. K. GOPALAKRISHNAN,
Exploratory Fisheries Project,
Bombay–400 001.

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7. SHRI. K. KRISHNA RAO,
Central Institute of Fisheries Technology,
Cochin–682 029.

8. SHRI. M.M. MEIYAPPAN,
Central Marine Fisheries Research Institute,
Cochin–682 018.

9. SHRI. P.M. MITRA,
Central Inland Fisheries Research Institute,
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Cochin–682 018.

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Central Marine Fisheries Research Institute,
Cochin–682 018.

14. DR. P. NATARAJAN,
Department of Fishculture,
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Tuticorin–628 003.

15. SHRI. K. K. P. PANIKKAR,
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16. DR. P. PARAMESWARAN PILLAI,
Central Marine Fisheries Research Institute,
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17. DR. S. RAMAMURTHY,
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18. SHRI. T.M. SANKARAN,
College of Fisheries,
(Kerala Agricultural University),
Cochin–682 506.

19. Shri. M Srinath,
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20 Dr. V. Sriramachandra Murthy,
Central Marine Fisheries Research Institute,
Kakinada–533 002 Andhra Pradesh

21. Shri. C. Suseelan,
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Cochin–682 018.

22. Shri R. Thiagarajan,
Central Marine Fisheries Research Institute,
(Regional Centre)
Mandapam Camp–623 520.

23. Shri R.K. Tyagi,
Central Inland Fisheries Research Institute,
Allahabad–211 002.

24. Shri. K. S. Udupa,
Fisheries College, Mangalore–575 002.

25. Shri T.M. Yohannan,
Central Marine Fisheries Research Institute,
Calicut–673 005.

Appendix III

Course material supplied to the participants of FAO/DANIDA/ICAR National Training Course at CMFRI, Cochin.

1. FAO Fisheries Technical Paper No. 203. Life cycles, dynamics, Exploitation and Management of coastal penaeid Shrimp Stocks.
2. CECAF/ECAF Series 81/22: Eastern Central Atlantic Fisheries.
3. FAO/DANIDA/GCP/INT/392/DEN Fisheries Economics-Lecture by Hans Lassen.
4. FAO/DANIDA/GCP/INT/392/DEN. Models as Stock assessment tools-lecture by Erik Ursin.
5. FAO/DANIDA/GCP/INT/392/DEN. Case Study III San Miguel Bay by Daniel Pauly.
6. FAO/DANIDA/GCP/INT/392/DEN. "Do's and Don'ts" in tropical assessment-lecture by Daniel Pauly.
7. FAO/DANIDA/GCP/INT/DEN. The Roles of the Fishery Biologist-lecture by J. Moller Chiistensen.
8. FAO/DANIDA/INT/392/DEN. Case Study 4 by Hans Lassen.
9. FAO/DANIDA/GCP/INT/392/DEN. The Tropical, the Temperate and the Arctic seas as media for fish production-Lecture by Erik Ursin.
10. FAO/DANIDA/GCP/INT/392/DEN. Case Study I by Daniel Pauly and P. Martosubroto.
11. Case Study II; Offshore Trawling Survey Work report No.8, UNDP & Govt of Kenya.
12. FAO/DANIDA/GCP/INT/392/DEN. Case Study III by P. Sparre.
13. FIDP/FAB/80/015. Assessment of the Shrimp Stocks of the West coast of the Gulf between Iran and the Arabian Peninsula,
14. FAO/TF/INT/180(C) (CAN) Suppl Selected lectures from the CIDA/FAO/CECAF. Seminar on Fishery Resources Evaluation.
15. Manual of sampling and Statistical methods for fisheries Biology - Part I - Sampling methods (FAO)
16. Mesh regulation in the demersal fisheries of the South China Sea area by R. Jones.
17. FAO Fisheries Circular No. 701 Models for fish stock assessment
18. FAO Fisheries Circular No. 734. The use of length composition data in fish stock assessment.
19. FAO Fisheries technical paper No. 234. Some simple methods for the assessment of tropical fish stocks.
20. ICFC/DEV/71/2. Survey of resources in the Indian Ocean and Indonesian area.
21. FAO Fisheries Technical paper No. 171. Survey methods of appraising fishery resources.
22. Language of symbols-lecture notes on basic mathematics—K. Alagaraja.

23. Study of variations-Lecture notes on basic statistics (measures of central tendency and dispersion)—K. Alagaraja.

24. Elements of Statistical regression and correlation —lecture notes by K. K. Ghosh.

25. A note on distinguishing features of ordinary cohort analysis and Length Cohort analysis-Lecture notes by K.K. Ghosh.

26. Technique of analysis of variance in relevance to trawl surveys-Lecture notes by K.K. Ghosh.

27. Sampling-Lecture notes by K. Alagaraja.

28. Small-scale fisheries of San Miguel Bay, Philippines: Biology and stock Assessment. Edited by Daniel Pauly and Antonio N. Mines. – ICLARM Technical Report–7.

29. Fish Stock Assessment: A manual of basic methods: J.A. Gulland.
FAO/Wiley Series on Food and Agriculture. Vol.1.

30. Analysis of marine fish landings in India - A new approach.
CMFRI Special Publication Number–10.

31. Pocket Calculator.

32. A set of parabolas (8 Nos.).

Appendix IV

The following committees functioned for the successful conduct of the FAO/DANIDA/ICAR National Training Course held at CMFRI Cochin during 7 November to 9 December 1983.

1. **Transport and Accommodation Committee**

Convenor: Shri. S.K. Dharmaraja

Members: S/Shri. V.K. Pillai, R. Sathiadas, M. Srinath and V. Jacob.

2. **Secretarial Committee**

Convenor: Shri. T. Jacob

Members: S/Shri K.N. Kurup, K. Balan and Smt. Krishna Srinath.

3. **Conference/Lecture hall amenities Committee**

Convenor: Shri. G. Venkataraman

Members: S/Shri. G. Balakrishnan, U.K. Sathyavan, C. Suseelan, Joseph Andrews and Haja Najeemudeen.

4. **Finance Committee**

Convenor: Dr. K. Alagaraja

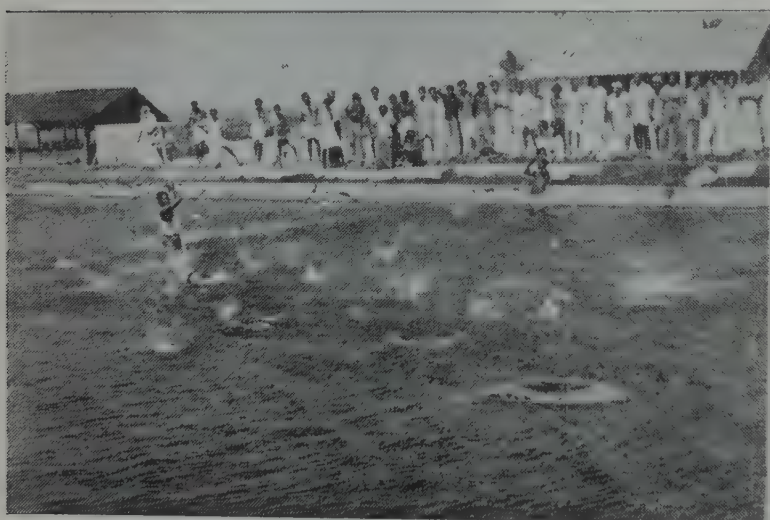
Members: Dr. P.P. Pillai. S/Shri K.K.P. Panikkar and M. M. Meiyappan

FISH HARVEST MELA AT CALICUT

A fish harvest mela to demonstrate to the fish farmers the technical feasibility of converting the derelict sandy shores to productive fish ponds by providing polythene lining in excavated pond areas and culture of economical fishes like milkfish and marine prawns was conducted at the Research Centre of Central Marine Fisheries Research Institute, Calicut on 31st December, 1983.

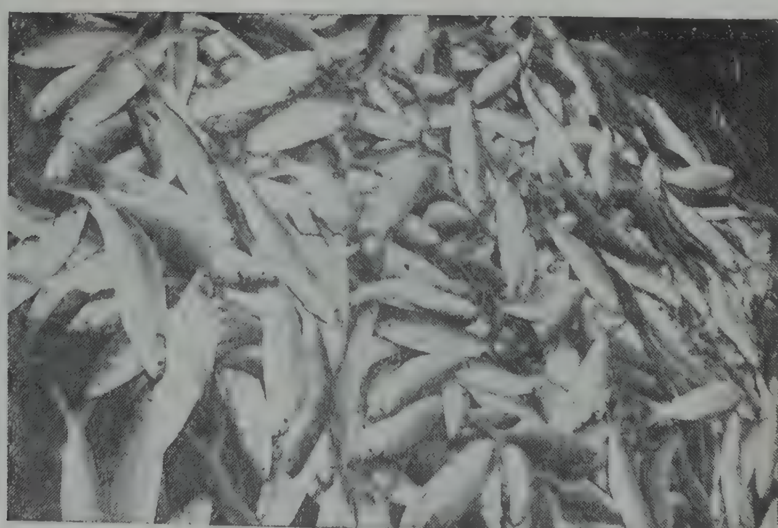
The fish harvest which started by 11 A. M. was over in the evening by about 3 P. M. A total of 278 kg. of *Chanos chanos* (Poomeen) was harvested from 3 ponds having a total area of 0.18 ha. The maximum length and weight of the fish was observed to be at 375 mm. and 380 gm. respectively. The fishes were sold to the public at the rate of Rs. 10/– per kg. on the spot.

A public meeting held in this connection at the Marine fish farm was presided over by Dr. P. V. Ramachandran Nair, Scientist of CMFRI. Mr. A Sankaran, Mayor of Calicut Corporation as the Chief Guest pointed out the importance of fish as a protein rich food and appreciated the efforts of the CMFR Institute in various methods of culture of fishes.



Fishing in progress

Mayor Mr. Sankaran watching the catch taken



Harvested fish

OBITUARY

Professor P. N. Ganapati

Professor P. N. Ganapati, Honorary Professor in Zoology, Andhra University, Waltair, passed away on the morning of 5 January, 1984 in Bombay after a brief illness. He was returning home after his 6 month tour to U.S.

Born on 15 July, 1910 in a village near Palghat. Professor Ganapati had his early education in Ernakulam. Later, he moved to Madras where he graduated from the Presidency College in 1932. He took his M.A. Degree in 1934 and later the D.Sc. in 1942 from the Madras University. After a brief assignment in the Central Marine Fisheries Research Institute, Mandapam, Professor Ganapati went abroad to receive advanced training in research in Parasitology at the Molteno Institute of Parasitology, Cambridge, where he worked for over two years.

After his return from England in 1949, Professor Ganapati joined the Zoological Laboratories at the Andhra University, Waltair, at the instance of the then Vice-Chancellor, Sir C. R. Reddy. Later, he became the Head of the Department there succeeding his predecessor, late Professor R. Gopala Iyer, who was also his teacher. Professor Ganapati retired as the Head of the Department of Zoology in 1970 and since then he continued there as an Emeritus Professor. Recently, the University had honoured him by appointing him as a Honorary Professor. Apart from showing keen interest in his chosen field of specialisation namely, parasitology, Professor Ganapati promoted active research in Marine Biology. He was virtually the first scientist to organise systematic oceanographic research in India along with other renowned oceanographers, Dr. E. C. LaFond and late Professor C. Mahadevan. Professor Ganapati was in charge of several scientific projects in Marine Biology sponsored by the I.C.A.R., I.N.S.A. and other scientific organisations. Apart from serving as Assistant Research Officer in Central Marine Fisheries Research Institute for a short period in the early years, he was very much involved with the affairs of the Institute for the past several years. Dr. Ganapati served as Chairman of the ICAR Scientific Panel for Fisheries. As Chairman of the Achievement Audit Committee of the Institute he conducted the achievement audit/quinquennial review for the periods 1970 to 1975 and 1975 to 1980.

His participation in the International Indian Ocean Expedition (1958–63) resulted in the collection and publication of very valuable data pertaining to the Indian Ocean, Bay of Bengal and the Arabian Seas. He published over 200 research papers in this field and some 25 candidates have obtained their doctorate degrees under his supervision. A Fellow of the National Academy of Sciences, India, Professor Ganapati served in various capacities on several national and international academic bodies including UNESCO, INCOR, SCOR, IOBC, ICAR, CSIR, ZSI, FRI and numerous Universities. Professor Ganapati has a number of admirers, his students and others who are occupying high positions in India and abroad.

He is survived by his wife, two sons and two daughters.

Compiled and prepared by M. J. George, K. Alagaraja, G. Subbaraju & S. K. Dharmaraja

Published by Dr. M. J. George, Senior Scientist on behalf of the Director, Central Marine Fisheries Research Institute, Cochin-682 018 and printed at PAICO, Cochin-31

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No. 57
MAY, 1984

Technical and Extension Series

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

COCHIN, INDIA

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the National Marine Living Resources Data Centre (NMLRDC) and the Research Divisions of the Institute, results of proven researches for transfer cf technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

Abbreviation – *Mar. Fish. Infor. Ser. T & E Ser.*, No. 57: 1984

CONTENTS

Front Cover:

The Krill of Antarctica — the richest single species marine resource in the world.

Back Cover:

"Parental care in Antarctica. The newly hatched chick is being cared by a pair of Emperor Penguins"

THE THIRD INDIAN ANTARCTIC RESEARCH EXPEDITION AND THE ROLE PLAYED BY CMFRI

K. J. Mathew

Central Marine Fisheries Research Institute, Cochin-682 018

Introduction

India entered the Antarctica Era when a team of 21 Indian nationals landed in Antarctica on 9th December, 1981. It was a big leap forward for the Indian science and technology and was much acclaimed the world over. It was indeed a tremendous achievement for a developing country like India. The whole programme was due to the initiative and encouragement of Prime Minister Smt. Indira Gandhi.

The pioneering Indian team initiated some useful research works in the continent and in the adjoining seas. Following the success of the first Expedition a second team of 28 men was sent in 1982 to make follow up studies of the programmes already begun during the first Expedition and also to open up new areas of research by staying for a longer period in Antarctica.

The Third Indian Antarctic Research Expedition, in which the author was a scientist member, was unique in several respects. The personnel contingent of 81 was the biggest India had ever sent to the icy continent. The chief task of the Expedition was to build a permanent base station during one Antarctic summer which could house 12-16 personnel during winter. This was quite a big challenge because in the history of Antarctic explorations, no country has achieved such an objective in one Antarctic summer which would last for hardly two months. The Antarctica is notorious for its blizzards and unpredictable weather which could minimise the working days to a great extent.

Besides the above objective the 16 member scientific team had several research programmes to carry out in the Antarctic Ocean and on the continent. The team of scientists included three marine biologists, one oceanographer, one chemist, two geologists, one glaciologist, one seismologist, two meteorologists, one oil and natural gas expert, three communication experts and one amateur radio operator. The author was to carry out investigations on various aspects of 'krill' (*Euphausia superba* Dana) a protein rich and vitamin rich crustacean which looks like tiny shrimp and would grow to about 55 mm in length and has vast resource in Antarctic Ocean with a circumpolar distribution. The article embodies a general account of the experiences of the author during the Expedition with special reference to the various activities undertaken during the Expedition. A detailed report of the work carried out by the author and also the results obtained on the quantitative abundance of zooplankton in the respective study areas is also included.

I. The Expedition in General

Preparations for the Expedition

All members of the Expedition had to undergo a medical checkup at the army hospital in Delhi and a training on the glaciers in the high altitudes in the Himalayas. The scientists had their training from 17–9–1983 to 25-9-1983. The training included walking on ice, climbing vertical ice cliffs, step cutting, rope climbing, crossing crevasses etc. The training was imparted by the High Altitude Warfare School at Sonamarg. (Plate I Fig. 1).

On 2nd November, the members of the Expedition were called to Delhi for briefing about the Expedition. They were addressed by the Secretary, D.O.D., Deputy Chiefs of the three Services and the leader of the Second Antarctic Expedition. The scientists were told to report in Goa in the 3rd week of November with all preparations for their scientific works in Antarctica.

The Task

The objectives of the Third Indian Antarctic Research Expedition were identified as follows.

Logistics

1. To carry out a quick survey of the area to ensure that the site selected for the Base Station by the Second Expedition is stable and capable of taking the weight of the proposed structure.
2. "To erect the building for the Permanent Indian Station and equip it with all essential services like power, water, heating, seawage disposal etc.
3. "To establish direct communication link between India and the Base Station in Antarctica.
4. "To test the reliability of the structure and other essential equipment. If these are found satisfactory, to leave a team of 12 to 16 persons behind for wintering in Antarctica."

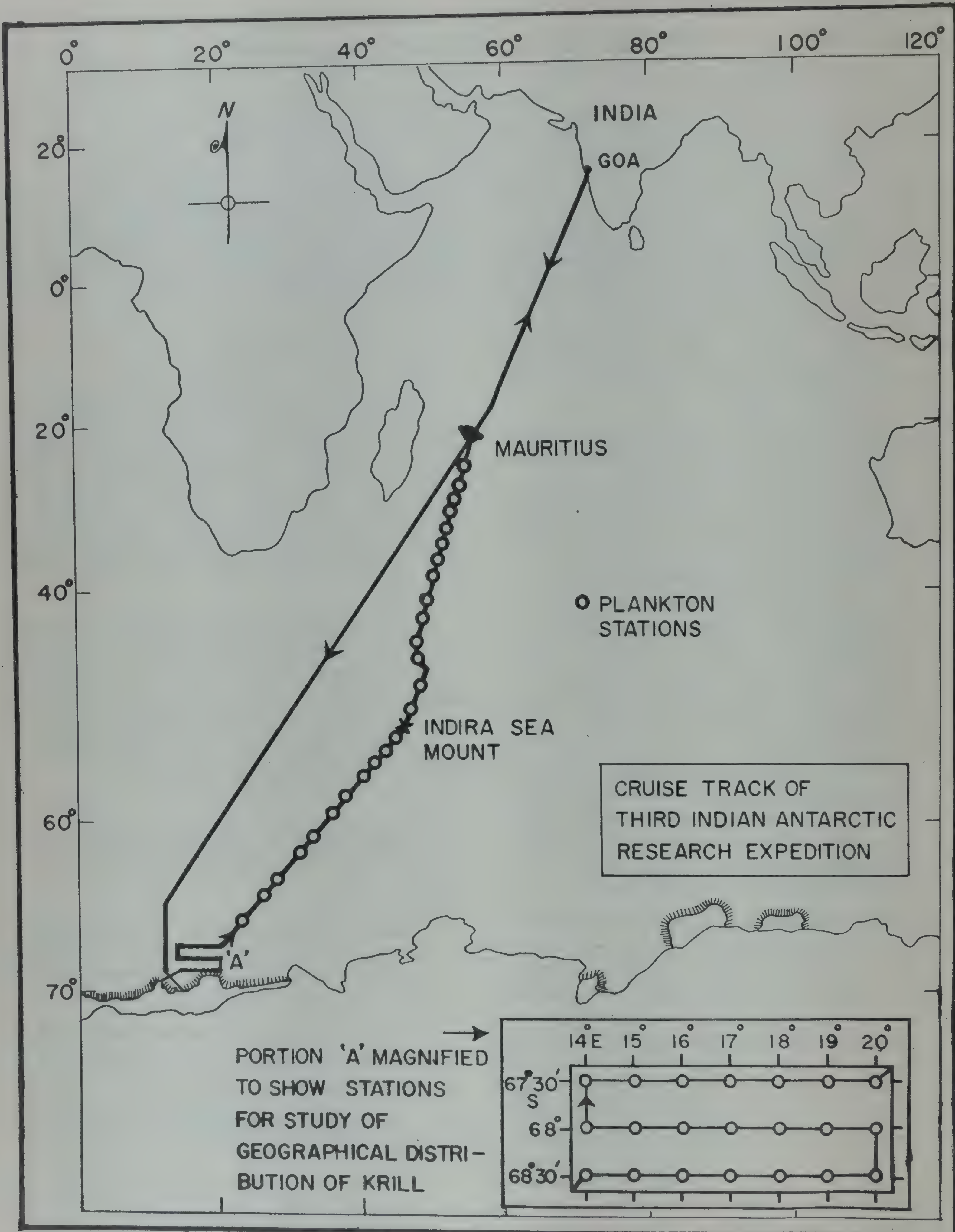


Fig. 1. The cruise track of M.S. *FINNPOLARIS* – the vessel used for the 3rd Expedition

Scientific

a. **Marine Biological and Oceanographic Studies**

1. "Assessment of geographic distribution, composition and biomass of 'krill' and other zooplankton in the coastal and oceanic waters in the southern seas.
2. "Studies on thermocline structures and coastal and oceanic water masses in the southern ocean along a section from Antarctica to Mauritius.
3. "Distribution of and inter-relationships between various chemical constituents of seawater, such as inorganic micronutrients, dissolved oxygen and components of carbon dioxide systems in relation to physical and biological features.
4. "Speciation of phytoplankton involved in primary biochemical end products of photosynthesis.
5. "Microbiological studies in sediments and sea water."

Limnological studies

1. "Physical and chemical studies in the fresh water lake systems in relation to carbon, nitrogen and phosphorous cycles.
2. "Phytoplankton and benthic species and the biochemistry of their photosynthesis in relation to light and temperature.
3. "Zooplankton quantitative studies, speciation and specimen collection.
4. "Microbiological studies in continuation of the earlier work."

Aerosol studies

1. "Sampling for analysis of various radioisotopes for studies on air mass movements and trace elements at Bhaba Atomic Research Centre and microbiological work at Marathwada University."

Soil analysis

1. "Sampling of soil for radioactive analysis at BARC to assess levels of remnants of nuclear explosions in Antarctica.
2. "Chemical analysis of cations, cationic exchange capacity, pH and organic carbon contents."

Chemical studies of other constituents

1. "Chemistry of ice and snow samples.
2. "Analysis of moss and lichen chemistry."

Geological studies

1. "Collection of samples for petrological, geochronological, geochemical, palaeontological, sedimentological and palaeomagnetic studies.
2. "Representative meteorite sample collection.
3. "Geomorphological, glaciological and structural studies.
4. "Coastal shelf area studies with special reference to submarine geology."

Geophysics

1. "Seismic refraction experiments for estimating ice thickness at various sites.
2. "Magnetic profiles extending to several kilometres using two proton precision magnetometres."

Habitat development studies

1. "Investigations of density, strength and deformation profiles of snow cover for foundation and superstructure designing.
2. "Wind movement and direction based on snow deposition studies.
3. "Evaluation and testing of engineering equipment and products."

Communications

1. "Different kinds of antennae to be tried for communication stability in the Antarctic environment, and operation of an Amateur radio."

Meteorological programme

1. **In the ocean**
   a. "Measurement of surface pressure, temperature, humidity and wind velocity.
   b. "Radiosonde/omegasonde measurements of upper air pressure, temperature and humidity".
2. **Over Antarctica**
   a. "Both of the above.
   b. "Surface ozone, snow catch and radiation regime of Antarctica."

Personnel and Facilities for the Expedition

The personnel contingent consisted of 81 Indian nationals selected from the three armed services and from various research Institutes of the country. The scientific team was composed of 16 members of which one was an amateur radio operator.

The Expedition was conducted using a Finnish vessel, *FINNPOLARIS* of 159.22 m length. The ice-strengthened vessel was specially designed for navigation in the polar seas. It could hit and smash sea ice of upto 0.75 m thickness. The main engine had a power of 9900 hp. The Expedition carried with it four helicopters (two larger ones from the Indian Air Force which could carry about 3 tonnes of cargo and two smaller

from the Indian Navy), four snow vehicles each having a load capacity of 10 tonnes, snow scooters, 200 tonnes of building materials, 2,000 barrels of fuel, snow cutting machines, three large generators, many small generators, living containers, boiler, two sets of equipments for satellite communication, many other communication equipments, and a lot many other major and minor items. The food materials and soft drinks amounted to a large quantity. The scientific equipments were in addition to the above.

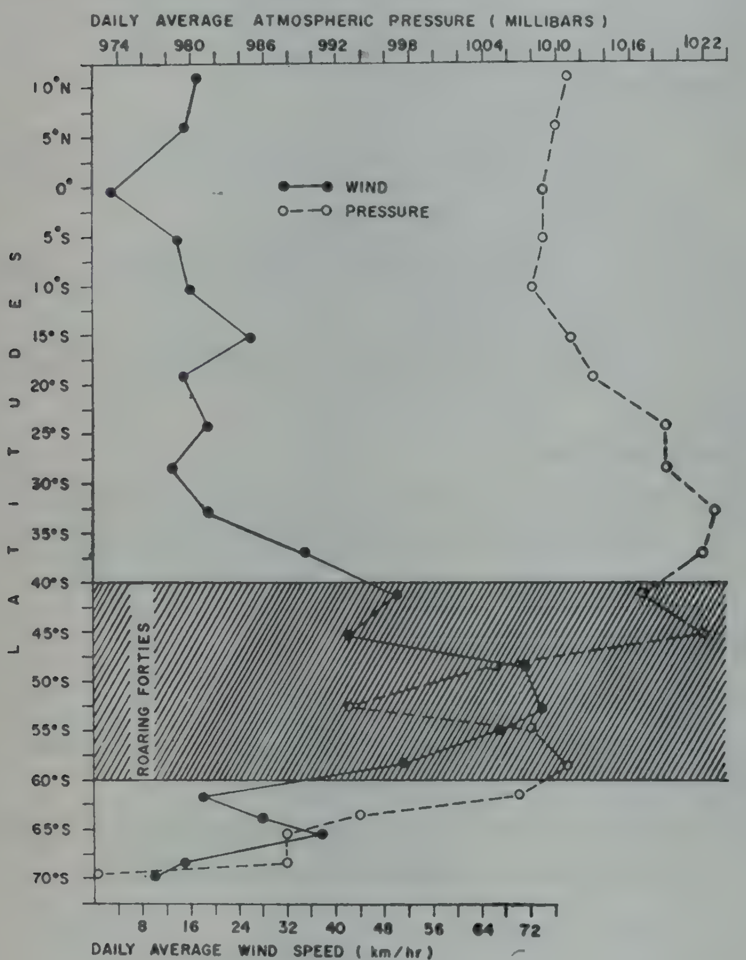


Fig. 2. The daily mean value of wind velocity and barometric pressure from Goa upto Antarctica.

The Voyage to Antarctica

With the above mentioned objectives and facilities the Expedition set sail from Goa on the 3rd December, 1983. The participants were given a heroic send off as the military bands played melodious tunes, the most touching being '*Sare Jahan se acha Hindustan hamara*' (of all countries in the world, our country, India, is the best). After moving out from the port of Goa, the ship took a south southwest course. The Fig. 1 shows the cruise track to and from Antarctica and also the plankton stations. On the way to Antarctica the ship cruised through a rather calm sea, crossed the equator on 6th December and reached Mauritius on 10th. After staying there for four days she sailed off to Antarctica. Passed through the roaring forties without any major storms or rough sea; on the other hand the fifties were quite rough with storms, high swells and breaking waves. The situation was almost the same during the homeward voyage also. Figs. 2 and 3 give the pattern of daily average wind and barometric pressure on way to Antarctica in December, 1983 and on way back in March, 1984 respectively.

Soon after crossing the 40°S latitude, the weather changed dramatically. The atmospheric temperature dropped from 22°C to 8°C in about 24 hour period. The daily average temperature recorded on board the vessel between Goa and Antarctica and back are given in Figs. 4 and 5 respectively. The first ice berg was sighted on 23rd December at 57° 25'S and 28°25'E where the atmospheric temperature was 3°C. (Plate I Fig. 2). Afterwards it was an usual sight.

On 25th of December, the ship started sailing through pack ice. (Plate I Fig. 3). As the ship went ahead the ice blocks on the surface of the sea became larger and thicker and at about 130 km away from the coast the ship had to be stopped on account of multi-year ice and thick sheet ice. One naval helicopter was engaged to find out the way and also a *'polynya' for safe anchorage

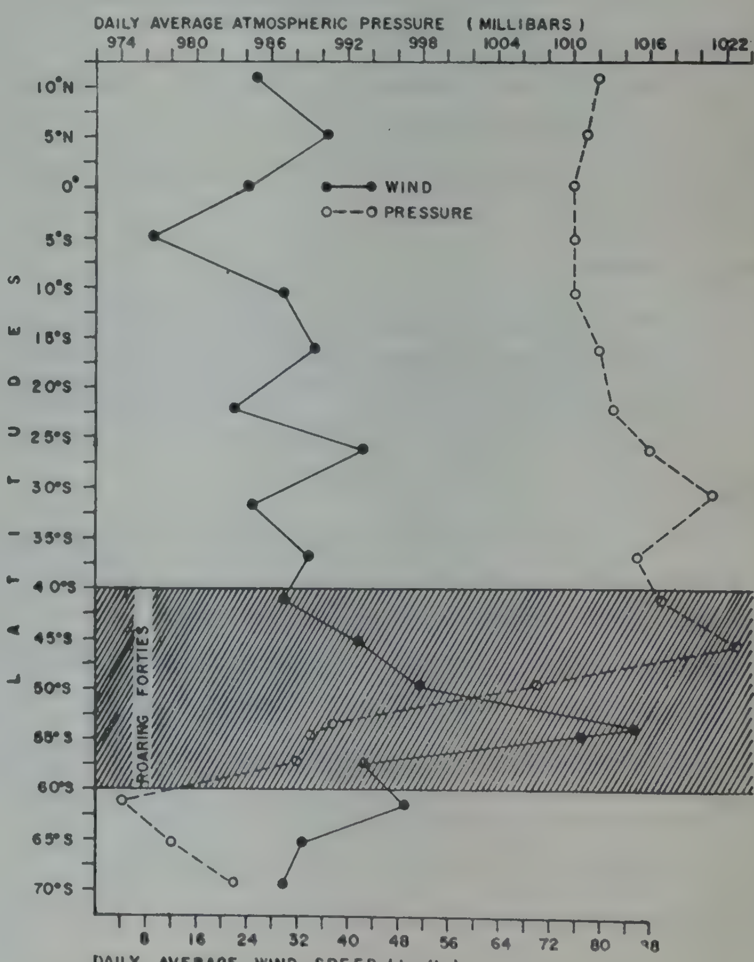


Fig. 3. The daily mean values of wind velocity and barometric pressure from Antarctica upto Goa.

* 'Polynya' is an ice free zone of limited extent in the ice covered sea.

Fig. 1 Training on the glaciers at the high altitudes in the Himalayas was a prerequisite for the Expedition. The author climbs up a vertical ice cliff using rope.

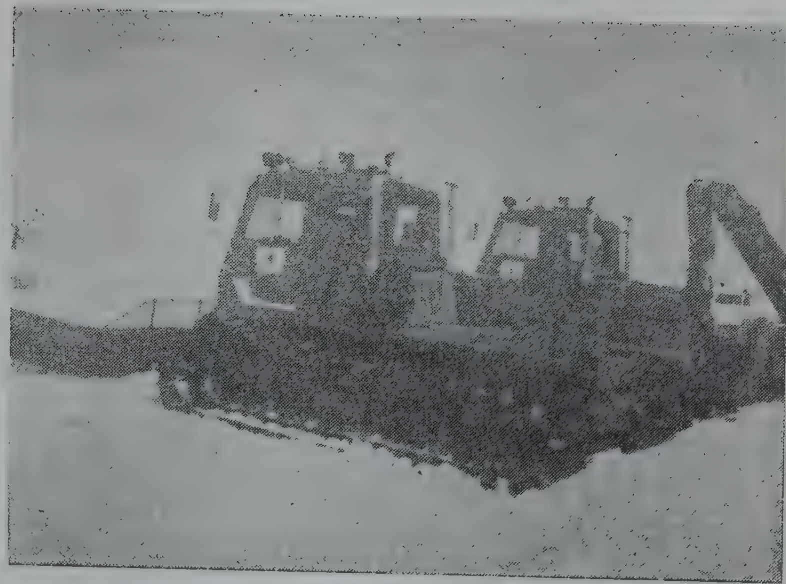


Fig. 4. The snow wolfs are really tough multipurpose snow vehicles which could pull loads of 10 tonnes over the ice.

Fig. 2 Ice berg – the floating ice mountain is an usual sight south of 60°S latitude.

Fig. 5. 'Skidoo' the snow scooter is a convenient vehicle for 2 men to go from place to place. In the background are the tents at the base camp which could withstand heavy storms.

Fig. 3. The ship is now passing through pack ice of about 1 m vertical thickness.

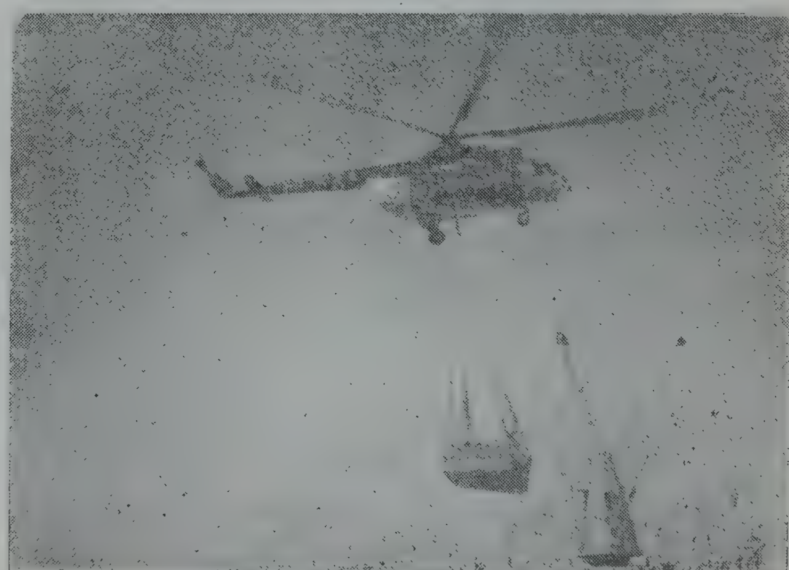


Fig. 6. Underslung operation. The large IAF helicopter MI–8 was the most useful carrier for men and materials.

of the ship. Eventhough the helicopter could guide the ship forward, the vessel could not reach the permanent shelf as there was still thick platforms of sea ice for about half a kilometre in front of the permanent

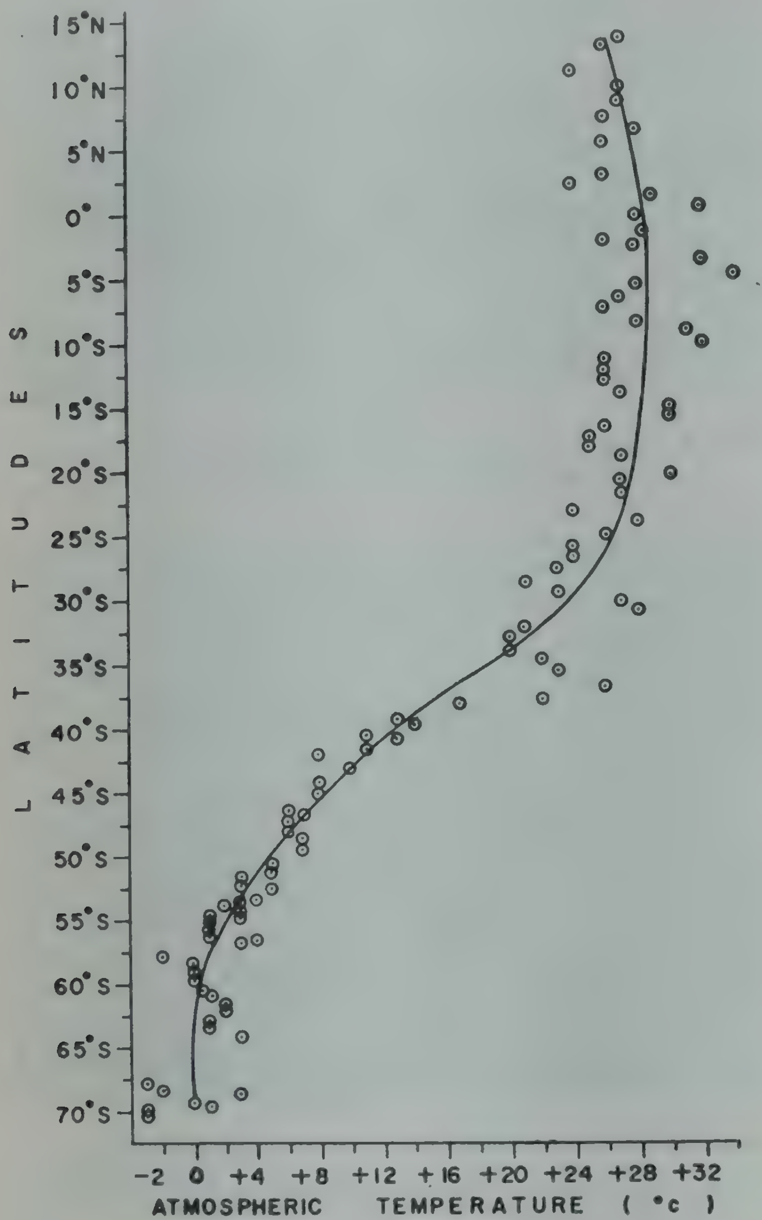


Fig. 4. The daily mean values of atmospheric temperature between Goa and Antarctica.

ice shelf. Therefore on 27th December by 0130 hrs while the sun was still shining in the sky, the ship was moored on to the sea ice and we landed in Antarctica.

Antarctic Continent

The antarctica is the highest, coldest, stormiest and driest continent on earth. The average height from the sea level is three times more than any other continents. It has an expanse of 14 million square kilometres which is roughly equal to India and China put together. 98% of the continent is covered by ice. The average thickness of the ice is 2000 m. The remaining 2% consists of exposed land of hills and mountains. 90% of the ice in the world is in Antarctica.

The continental shelf has a width of 30 km only against a global width of 70 km. At its seaward edge 400

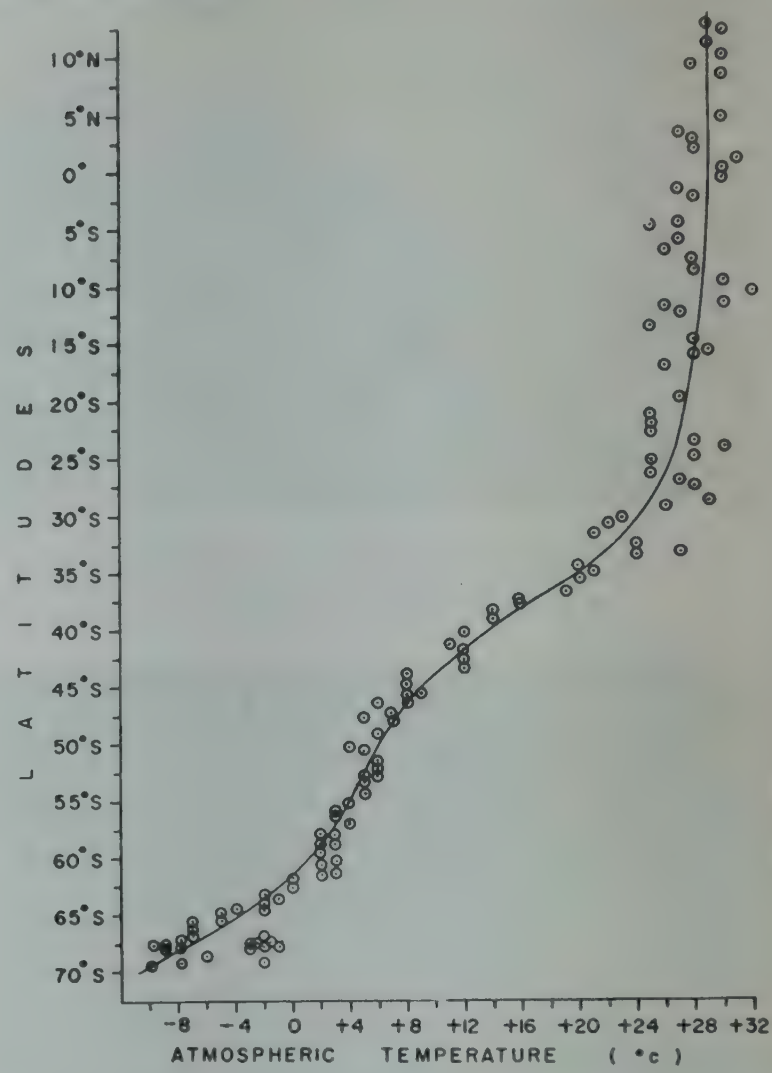


Fig. 5. The daily mean values of atmospheric temperature between Antarctica and Goa.

to 600 m depths are common. The cause of the abnormally deep shelf edge has been attributed to depression of the shelf by the ice load.

The summer average temperature may range between 0°C and – 30°C, whereas the average winter temperature may be between – 20°C and – 65°C. The world's lowest temperature of – 88°C has been recorded on 24th August, 1960 at *VOSTOK*, a Russian station.

The amount of sunlight Antarctica receives is very high. The total annual radiation at the south pole is about equal to that received in equatorial regions despite there being months of total darkness. This is because of the continent's high elevation, and therefore thin atmosphere and by the unusual transparency of the air.

The blizzards of Antarctica are notorious. They are high velocity cyclonic storms associated with snowfall and snow drift. They form over the southern oceans

and move clockwise around the continental coast. The wind speed can go upto 200 km/hr or more. The extreme cold in Antarctica makes it a dry continent. The moisture formed in the atmosphere gets condensed and fall down as snow.

Around the continent there is a vast expanse of sea ice. The ice pack grows from an average minimums of 2.6 million km^2 in March to 18.8 million km^2 in September. 85% of the Antarctic pack ice melts each year which has an average thickness of 1.5 m. The ice bergs, characteristic of the Antarctic seas are parts of the main continent cut away in course of time. Some of them may be gigantic with measurements of 100×60 km. There are ice bergs grounded at depths of 500 m.

Early Explorations

About 500 B.C. the ancient Greek philosphers logically concluded that there should be an antarctic continent to balance the earths weight in the northern hemisphere. Then for 2000 years the idea was lost until Columbus revived it. Later from 1772 to 1775 Captain James Cook sailed around Antarctic continent three times without sighting the continent.

In 1820 and 1823 Nathaniel Palmer of U.S.A. and James Weddel of U. K. respectively discovered the Antarctic Peninsula. In 1895 H. J. Bull of Norway made the first landing in the continent.

On 14th December, 1911 Roald Amundsen of Norway reached the geographic pole, the most spectacular achievement in the exploration of Antarctica. Again on 17th January, 1912 Robert Scott of U.K. also reached the south pole.

The International Geophysical Year of 1957-58 called for a co-operative venture for Antarctic exploration. Twelve interested countries agreed to combine forces and sent to Antarctica. These countries form the original signatories of the Antarctic Treaty.

Between 1900 and 1940 most of the continent had been claimed by seven countries namely U.K., Newzealand, Australia, France, Norway, Argentina and Chile. These countries and five more countries which co-operated during the IGY met and signed a draft Treaty in 1959. Eight more countries including India have been acceded since the Treaty entered into force. Although the Treaty freezes the existing claims, most claimants remain firm about their long term territorial rights out of national pride, possible economic gain and security considerations.

India Goes to Antarctica

It was under such situations that India decided to go to Antarctica and establish a base of her own.

On 9th December, 1981 a team of 21 Indian nationals landed in Antarctica. Followed by this a second Expedition was sent by India which made its landing on the 26th of December, 1982 and did scientific works establishing a temporary base. Following the success of the previous two expeditions, India sent a third expedition in December, 1983 with much wider scope. By this time India had obtained membership in the Antarctica Club but not in the Consultative Council of the Treaty Nations for want of a permanent station in Antarctica. The main objective of the Third Indian Expedition was to construct on ice a permanent station where scientists could stay year round. Besides, the 16 member scientific team had their own programmes to carry out on the continent and in the adjacent sea.

The Activities During The Third Indian Antarctic Expedition

Soon after reaching Antarctica, the team members started with the offloading operations. Among the first items unloaded were the heavy cargo such as the snow vehicles (Plate I Figs. 4 & 5) sledges, living containers etc. which were immediately required at the base camp and which could not be transported by the helicopters. The offloading of them on the sea ice which was about one metre thick involved great risk. But the need of the hour necessitated such an action.

A suitable site (70°05′37″ S 12°00′00″E) which was about 10 km. away from the previous years base camp and about 15 km from the ship was selected for the construction of the permanent station. Fig. 6 is a schematic representation of the ice shelf, sea ice, a

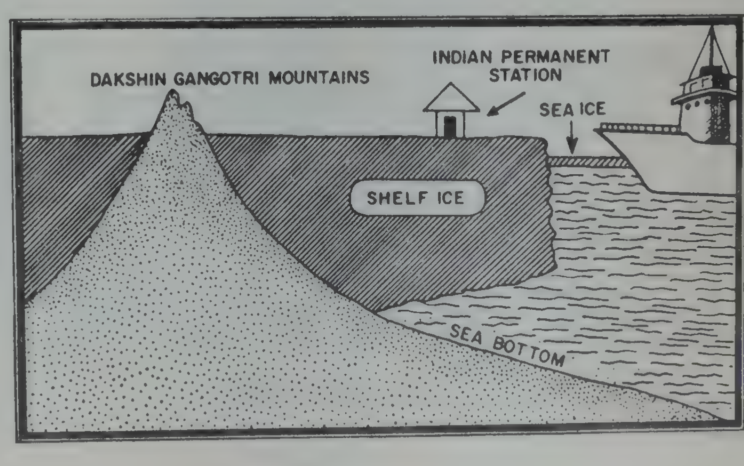
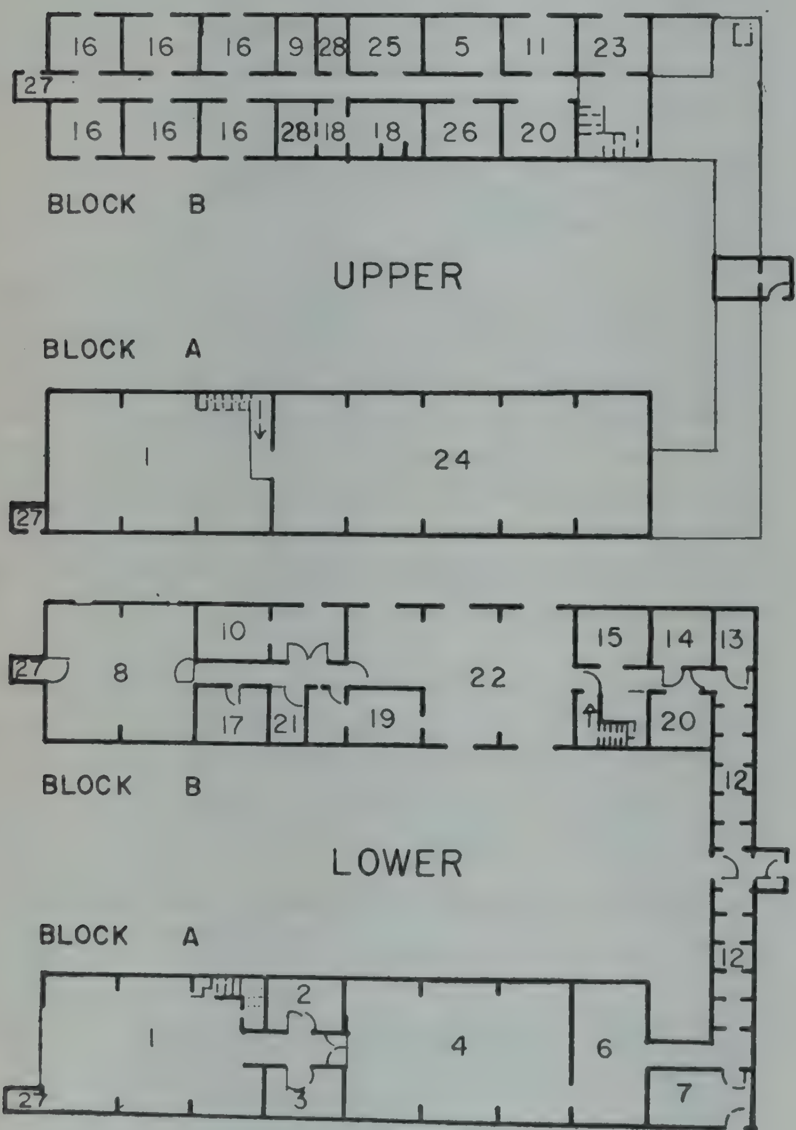


Fig. 6. Vertical profile of a part of the ice shelf and sea where the permanent Indian station is situated.

mountain range and the relative position of the permanent base station (not drawn to scale). Tents for the accommodation were erected by the first advance party. The air force helicopter was put into operation on 27th December itself for transpoιting the building and other essentials to the base camp (Plate I Fig. 6). Every member of the Expedition was to associate with the construction work in one way or other. Mainly the scientists were responsible for unloading the cargo from the ship. Everyone had to work for 8 to 16 hours or even more a day besides attending to the scientific works. The frequent blizzards, the loss of a large helicopter on the second day of arrival in Antarctica were enough to dampen the spirits of the members. But the rememberance that we were sent to work for a great national cause kept our morale up and gave us strength to work untiringly in such hostile weather and freezing temperatures. The work on the building progressed steadily but with interruption due to blizzards. However, the goal was achieved in 58 days which was a world record.

DAKSHIN GANGOTRI—The Permanent Indian Base Station

The base station consists of 2–two storeyed blocks–Block-A containing the living facilities, communication facilities and general stores in the first floor and a lounge, kitchen, hospital, laboratory and a snow melting plant in the ground floor. (Plate II Figs. 1, 2 & 3). The Block-B houses three generators, the electrical work



PLAN OF *DAKSHIN GANGOTRI*
BASE STATION

SCALE 1 : 100

1 GARAGE WORKSHOP
2 ELECTRICIANS WORKSHOP
3 DIESEL MECHANICS WORKSHOP
4 GENERATOR ROOM
5 BOILER ROOM / DAILY OIL STORE
6 CARPENTER'S WORKSHOP
7 WEEKLY OIL STORE
8 LABORATORY
9 DARK ROOM
10 SURGERY
11 BASE COMMANDER'S OFFICE
12 ACCESS LINK
13 MELT TANK
14 SNOW MELT PLANT
15 OUTDOOR CLOTHING STORE
16 TWO MAN BUNKROOM
17 LAUNDRY
18 WASH ROOM AND TOILETS
19 KITCHEN
20 COLD ROOM
21 LARDER
22 DINING ROOM / LOUNGE
23 RADIO ROOM
24 MISC. STORAGE
25 SCIENTIFIC EQUIPMENT STORE
26 FOOD AND GENERAL STORE
27 ESCAPE SHAFT
28 TOILETS

Fig. 7. The lay out of the permanent Indian station – the *Dakshin Gangotri*.

shop and carpentry on the ground floor. In the upstairs are again some of the workshops and the general stores. Connecting the two blocks is the link block which provides the passage from one block to the other. The buildings which are entirely made of wood, asbestose and thermocol are centrally heated. The permanent Indian station has been christined as *Dakshin Gangotri*. Fig. 7 is the lay out of the permanent station put up by the 3rd Expedition.

A team of 12 members of which three being scientists are left behind for winteiing. The scientists would carry out investigations on glaciology, meteorology and microbiology.

The Amateur Radio Operation

The amateur radio operator (HAM) of the Expedition could establish contacts all through the Expedition with many amateur radio operators in India through whom many of the members could pass on and receive messages to and from their family members.

The Blizzards

The Expedition was caught in four major blizzards during its stay in Antarctica. The first one started on 6th January and lasted for two days. The wind speed rose to 78 km per hour. This blizzard affected the Expedition adversely in that all the excavations made for laying the foundation of the building were filled up with the drifting snow. The wind and blizzards experienced and the barometric pressure noted by the 3rd Expedition in the Antarctica are presented in Fig. 8.

The second blizzard hit the Expedition from 17th to 18th January. The maximum wind speed during this storm was 80 km per hour. Another blizzard which occurred lasted from 9th to 11th February. This time the maximum wind experienced was of the velocity of 90 km per hour. The severest of the blizzards was towards the end of February when all the construction works were over. The wind speed rose upto 133 km per hour which was the maximum registered at the ship's side during this Expedition. Fig. 9 is the

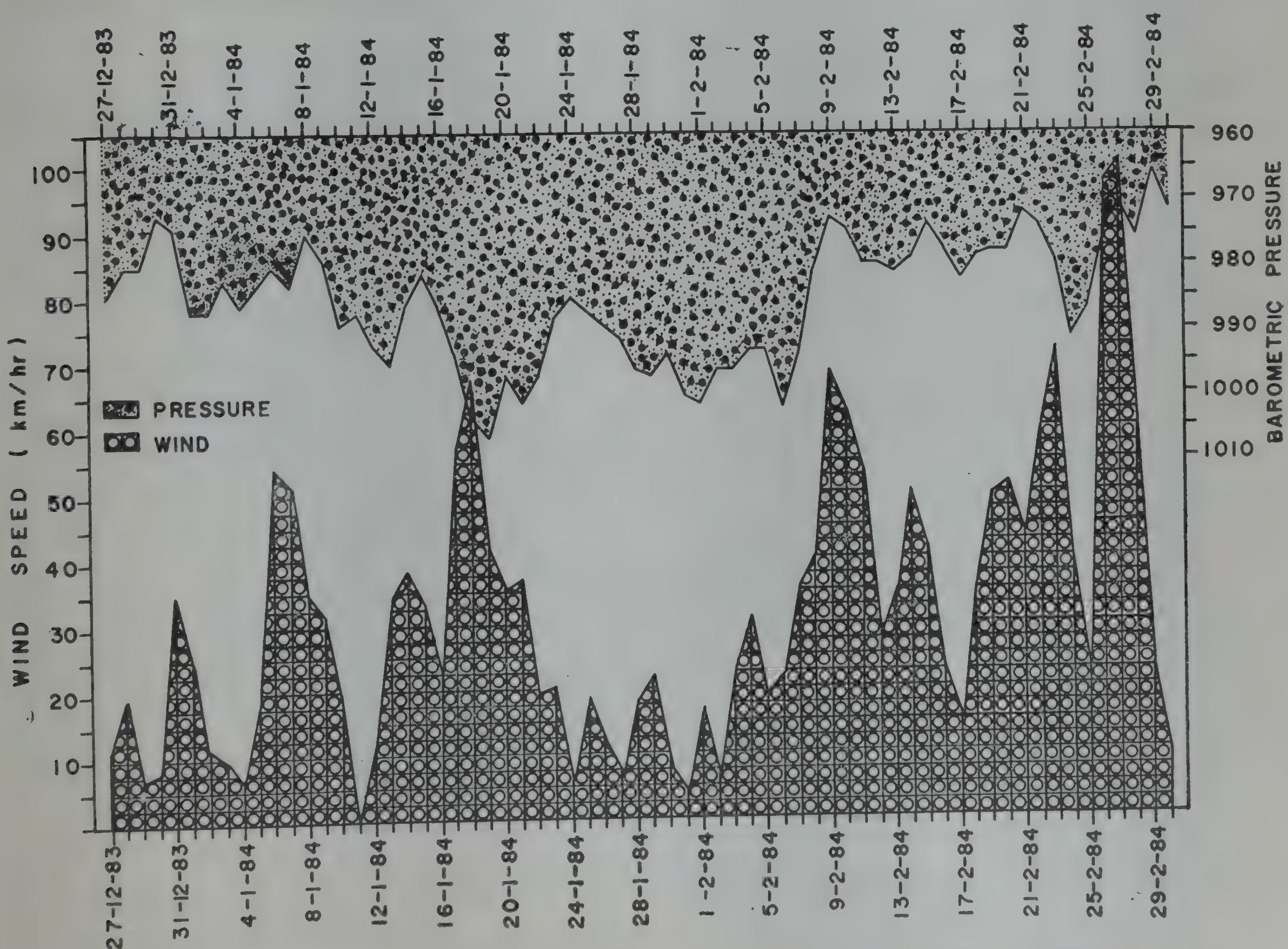


Fig. 8. The wind and blizzards experienced and the barometric pressure noted in Antarctica.

weather chart received by the FAX on board the vessel from the Russian Antarctic station *MOLODYOZHNAYA* on 26–2–1984 when the wind rose to the maximum velocity.

Temperature Conditions

The atmospheric temperature in Antarctica during the stay of the Expedition was below zero except during certain hours on some days in the summer when it went upto + 6°C. The lowest temperature, the 3rd Expedition experienced was –18°C at 0400 hrs on 25–2–1984. The daily average temperature recorded in Antarctica by the 3rd Expedition between 27th December, 1983 to 1st March, 1984 is presented in Fig. 10.

Fauna and Flora

The life forms on the continent are scarce. The plant forms are represented by mosses and lichens. The lower forms of animal life have also been recorded in the fresh water lakes in the rocky areas. The bird fauna is rich mainly with Adelie and Emperor Penguins (Plate II Fig. 4). Several other species of birds have also been recorded in and around the continent.

The depth soundings made in the Antarctic sea

The incidental findings of a deep and steep hole near to the ice shelf adjacent to the abandoned Russian Summer Camp, Lazarev, inspired the Chief Officer of the ship to undertake depth soundings of the nearby sea area. As a result he could make out a detailed depth chart for an area of more than 5,000 km² (Fig. 11).

The Schirmacher Mountains

About 70 km away from the Indian permanent station (70°44′S 11°39′E) is the rocky mountains known as Schirmacher mountains for which the First Indian Expedition has given another name, the *'DAKSHIN GANGOTRI.'* The mountains stretch for 15 to 16 km in length and has a width of ½ to 2 km. The highest peak is 212 m high. Because of the steep elevations,

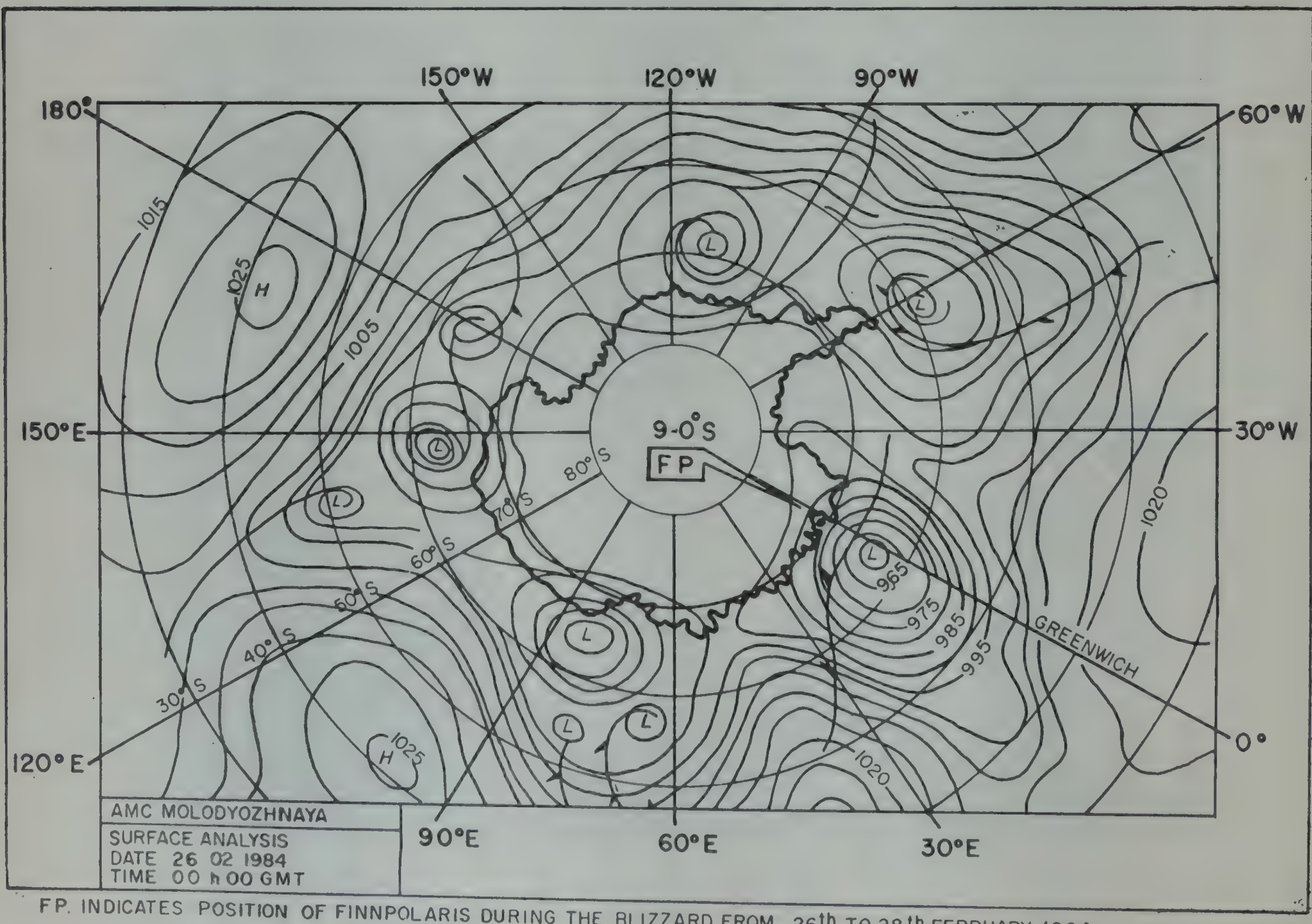


Fig. 9. The weather chart received on board the vessel from *Molodyozhnaya,* a Russian station in Antarctica on the day of severest blizzard.

during the summer, the snow cover on the rocks melts off and the water accumulates in the valleys to form fresh water lakes, pools and streams (Plate II Fig. 5). Even water falls are seen during summer. The rocks remain free of ice during this season. Good amount of geological works have been carried out by the Indian geologists in this area. Remains of dead birds were collected by the author from the Schirmacher mountains (Plate II Fig. 6).

Scientific and related work

The Leader of the Expedition in his report has made the following remarks about the scientific component of the Expedition and their work.

"This was an excellent team of scientists, and I wish to put on record my appreciation of the sincerity, devotion and discipline with which the scientists met with job requirements, both scientific and miscellaneous. Although not used to labour oriented jobs, scientists did not shrug from such work. They actively and effectively carried out loading/unloading operations and other odd jobs."

The scientific work were carried out on voyage to and from Antarctica, at the site where the ship was moored, at the base station and at the Schirmacher mountains. (The work on 'krill' and observations on birds have been given elsewhere in this report.)

1. Geological work

The camp at the Schirmacher mountains, mainly run by the geologists functioned for 24 days in January-February period. A detailed map of the mountain of about 35 km² area was prepared on 1:25,000 scale. The dominant rock types of the area were studied. Also samples were collected for minerological studies.

2. Meteorology

Meteorological parameters were monitored on board ship, at Base Camp and at Schirmacher mountains. Many radiosonde and omegasonde were released during the Expedition. A permanent station has been established at the Base Camp for year-round monitoring of the meteorological parameters.

3. Communication

Two satellite communication terminals of INMARSAT system have been installed at the Base Camp. The system provides telephone and telex link on a global basis.

4. Magnetic surveys

Total intensity measurements of earth's magnetic field were carried out at the Schirmacher mountains and on the ice shelf.

5. Biological and microbiological studies

A preliminary survey was carried out in five fresh water system in the Schirmacher mountains. The parameters studied included temperature, pH, chlorophyl *a* and productivity in the water column.

Diurnal and seasonal variations with regard to phytoplankton activity in shelf waters were investigated.

Fifteen stations were occupied on the north-bound transect from Antarctica to Mauritius for Chlorophyll *a* and ATP values and for oceanographic parameters.

6. Study on ionized and unionized atmosphere

This study being important in radio communication system was carried out by means of Riometer tuned to 20 MHZ and a microbarograph.

7. Chemical studies

Investigations of soil chemistry, vegetation and trace elements were conducted at the Schirmacher mountains.

8. Studies on bacteria and fungi

Around 1000 microbiologically distinct colonies have been isolated for further studies. A well equipped biological laboratory has been set up at the Base Station.

The winter starts

The winter started in Antarctica by the middle of February. As the winter set in, the temperature fell suddenly from minus 10°C to minus 20°C. The sea surface started freezing and there were frequent gales and blizzards.

Farewell to Antarctica

The 3rd Indian Antarctic Expedition completed its major task of constructing the permanent station by the 25th of February, 1984. After leaving the

Fig. 1. The construction work progresses against frequent blizzards and white outs.

Fig. 2. The *Dakshin Gangotri* – the 1st Indian permanent base station in Antarctica. Note the dome of satellite communication antenna.

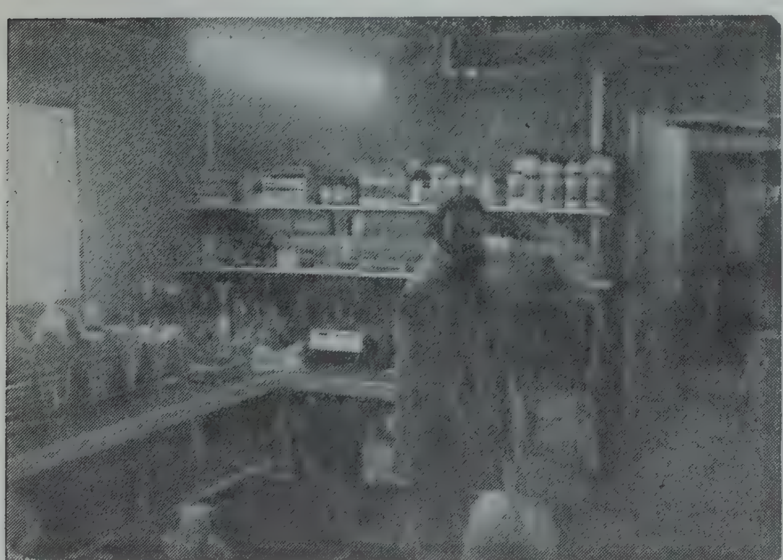


Fig. 3. The laboratory inside base station.

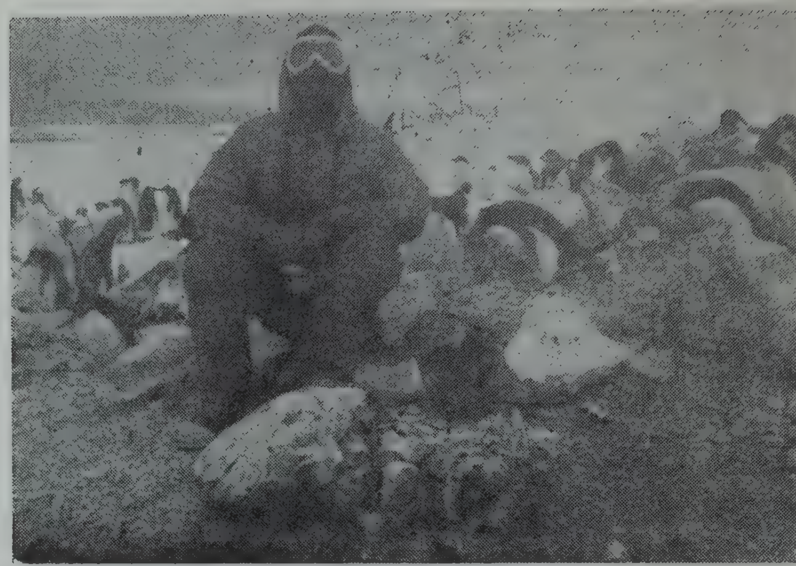


Fig. 4. One among the penguins. The author is on a visit to a small penguin rookery.

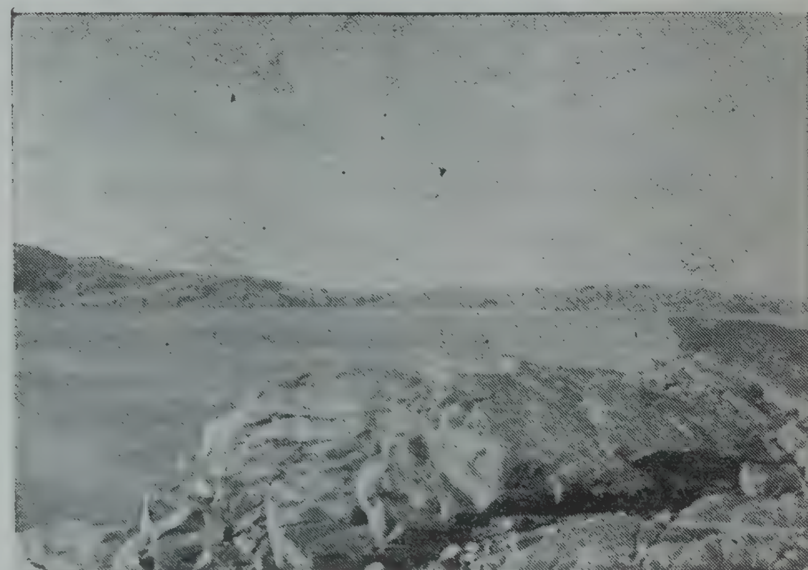


Fig. 5. A fresh water lake in the Schirmacher mountain, 70 km away from the Indian station.

Fig. 6. The ventral and dorsal sides of a young skua hunted upon by older birds. Recovered from the mountains.

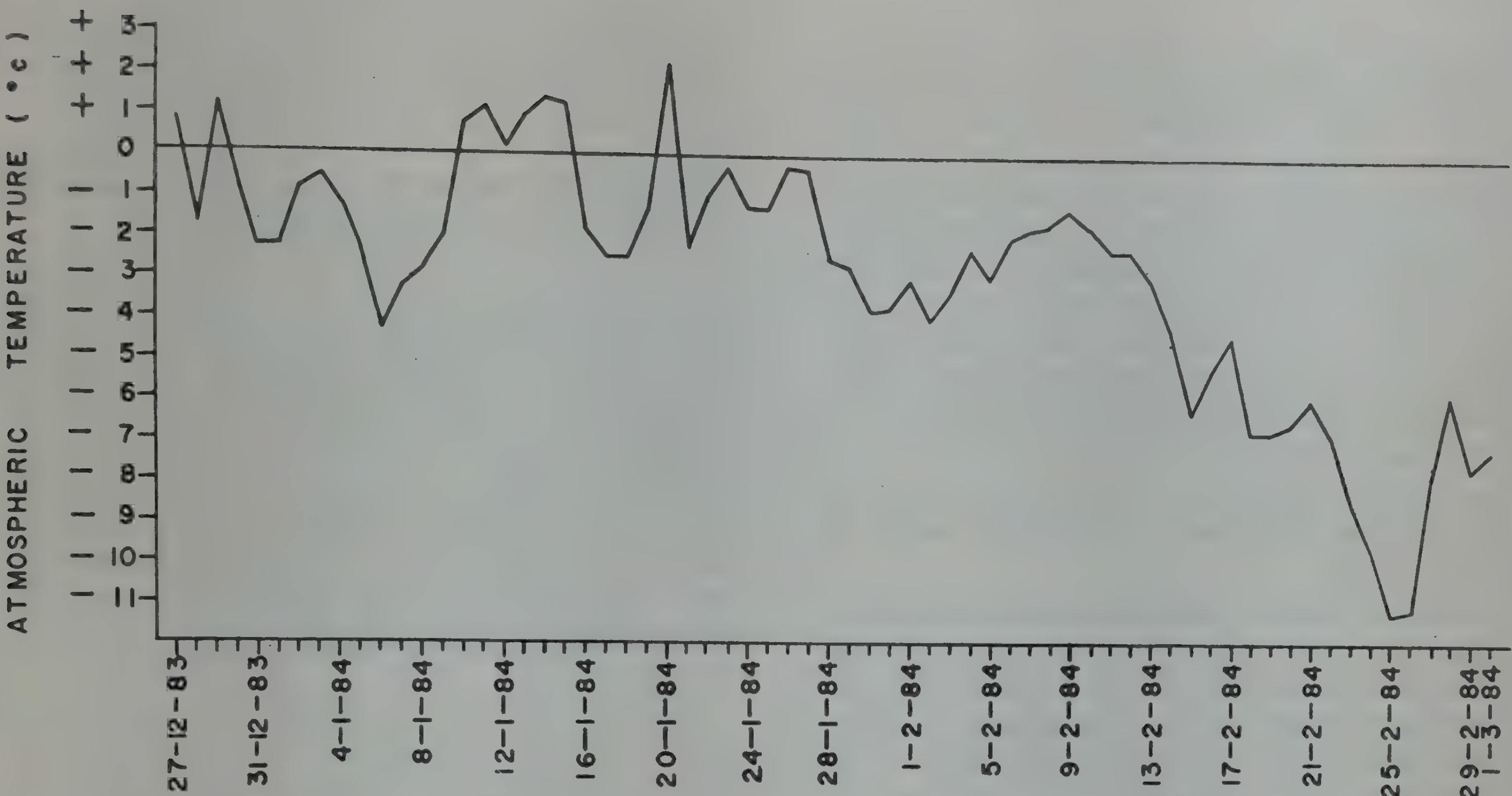


Fig. 10. The daily mean values of atmospheric temperature experienced by the 3rd Expedition in Antarctica.

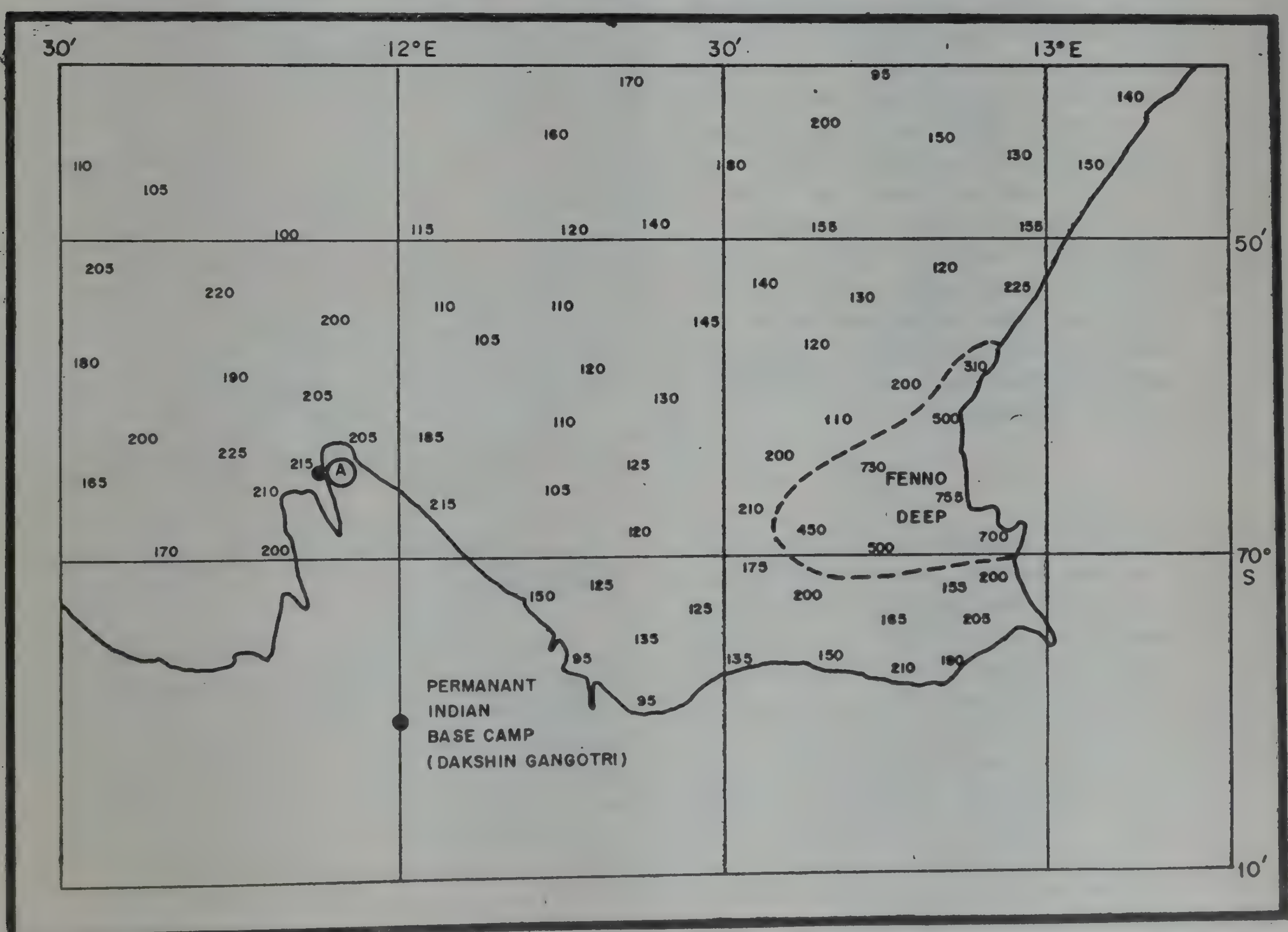


Fig. 11. The ocean depth chart made during the Expedition.

wintering team of 12 personnel at the Base Station the ship remained in Antarctica for four more days making a close watch on how the members of the wintering team managed at the camp. All went well and on the afternoon of 1st March the ship bade farewell to Antarctica. On the way back most of the marine biological and oceanographic works were carried out. The ship reached Mauritius on 19th March from where it left after four days. The Expedition with flying colours reached back in Goa on 29th March where the members were given a heroic welcome with *'AARATHY'* in the traditional Goan style.

II. Investigations carried out on the 'krill' resource of the Antarctic seas

Zooplankton samples for the study of distribution, abundance and biology of 'krill' (*Euphausia superba* Dana) and other zooplankton in general were collected using different types of gears (1) from a polynya, (2) at several localities distributed over a geographical area within the Antarctic convergence and (3) at a number of latitudinal stations enroute from Antarctica upto Mauritius. The whole sampling programme carried out during the Expedition can be considered under five categories that may result in the study of (1) variations in the diurnal abundance of zooplankton with special reference to krill in the euphotic zone in the polynya, (2) diurnal vertical migration of zooplankton with special reference to 'krill' in the euphotic zone in the polynya, (3) daily variations in the occurrence and abundance of zooplankton including the 'krill' in the polynya during the summer months, (4) geographical distribution and abundance of 'krill' and other zooplankton within the Antarctic convergence and (5) variations in the abundance of euphausiids and other zooplankton latitudinally from 68° 30′S upto Mauritius.

Methods

Four different types of nets were used for the sampling, of which two were specially meant for the collection of 'krill' and other macroplankton. The types of nets used were (1) two nets of 50 cm ring diameter having a mesh size of 0.4 mm and 4.0 mm respectively, (2) one Bongo Net of 60 cm mouth diameter having a mesh size of 0.4 mm, (3) one net of 113 cm ring diameter with 2.0 mm mesh size (modified Indian Ocean Standard Net) and (4) one mid-water trawl of 3.0 mm mesh size. The samples collected were preserved in 3% formaldehyde solution for laboratory studies. In the laboratory the displacement volume of total plankton and the numerical counts of euphausiids were taken. The following are the details of the work carried out under different categories. The total zooplankton obtained from the various samplings are also given diagrammatically.

1. Diurnal variations in the occurrence and abundance of 'krill' and other zooplankton in a polynya

A set of experiment running over a period of 24 hours was planned on 25–1–1984. Hourly collection of plankton using two half-metre ring nets of mesh size 0.4 mm and 4.0 mm respectively was made as open vertical hauls from 100 m to the surface. This was to understand the variations, if any, in the diurnal occurrence of 'krill' and other zooplankton in the epipelagic zone when there was sun light throughout the day. The diurnal variations in the abundance of zooplankton in general are given in Fig. 12.

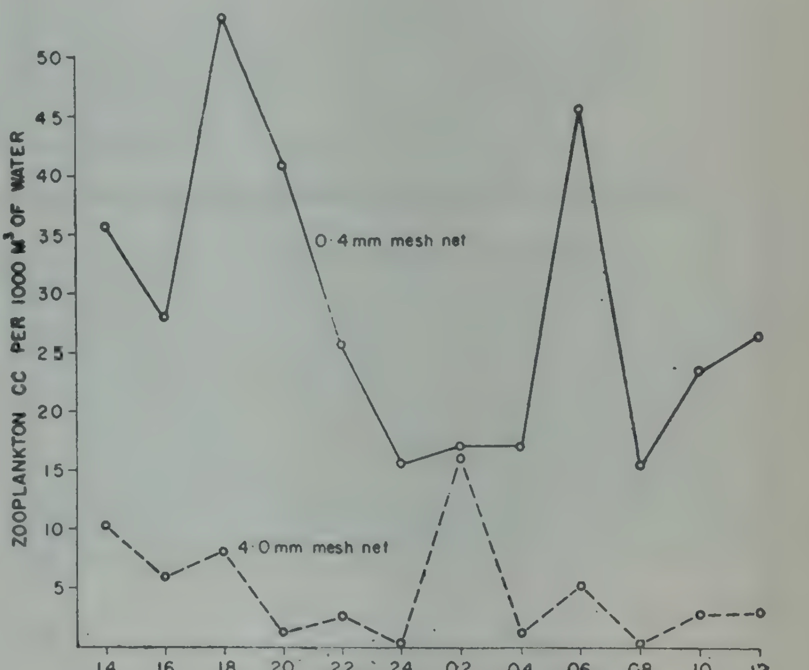


Fig. 12. Diurnal variations in the abundance of zooplankton in a polynya.

2. Vertical migration of 'krill' and other zooplankton in a polynya

A series of three hourly stratified sampling with a half metre ring net of 0.4 mm mesh size, attached with a closing mechanism, was carried out over a period of 24 hours starting on 31–1–1984 to study the vertical migration, if any, of 'krill' and other zooplankton towards the end of summer when there was light throughout the day, with a short period of dusk. The strata selected for sampling were 100 → 75 m, 75 → 50 m, 50 →25 m and 25 → 0 m. Figure 13 gives the pattern of stratified distribution of zooplankton at different times of the day.

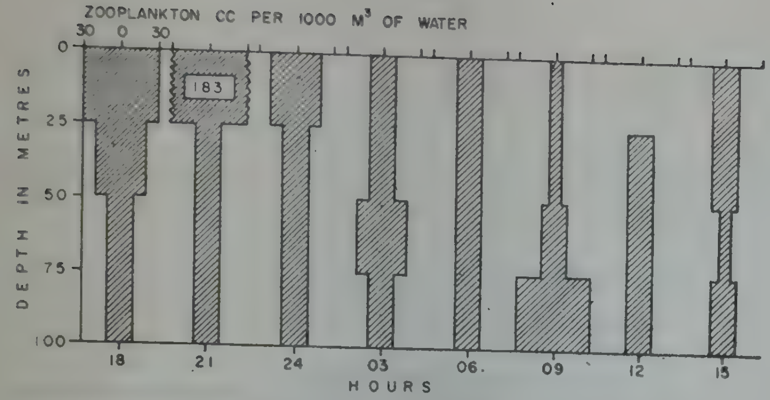


Fig. 13. Pattern of vertical distribution of zooplankton in a polynya.

3. Seasonal variations in the occurrence and abundance of 'krill' and other zooplankton in a polynya during summer

During the summer months when there is sun light for 24 hours a day, the production at the primary level attains the maximum. This was evident when blooms of phytoplankton clogged the nets in the earlier part of the summer. Normally a rich production of phytoplankton would be followed by an abundance of zooplankton. In order to understand the cyclical events taking place at the primary and secondary levels in a polynya, daily vertical sampling for zooplankton was

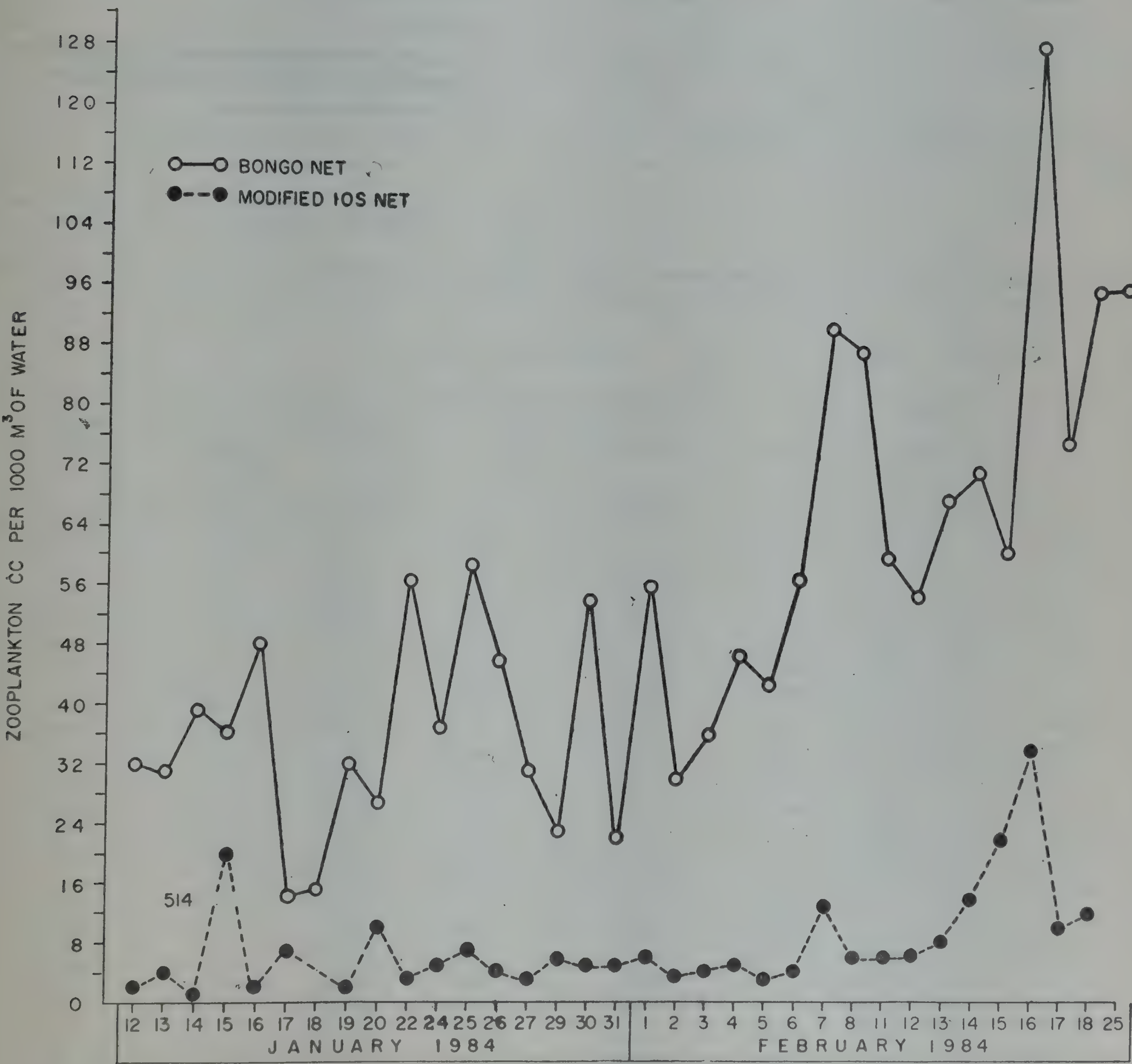


Fig. 14. Daily variations in the occurrence and abundance of zooplankton in a polynya in the summer months.

carried out around 1800 hrs over a period of more than a month. Two nets were employed; one Bongo-60 net and one modified IOS Net. 34 samples were collected from a depth of 150 → 0 m with the former net and 32 samples with the latter from 200 → 0 m. Figure 14 gives the zooplankton biomass obtained during the studies.

4. Geographical distribution of 'krill' and other zooplankters within the Antarctic Convergence

Twenty one sampling stations were fixed in three latitudinal grids of seven stations just north of the pack ice for the study of geographical distribution and abundance of 'krill' and other zooplankton in general. The area covered under the study was about 25,000 square kilometres between latitudes 68° 30′S and 67° 30′S and longitudes 14° 00′E and 20°00′E. The quantitative distribution of zooplankton and the 'krill' in the epipelagic zone of the area covered (150 → 0 m) is shown in Table 1.

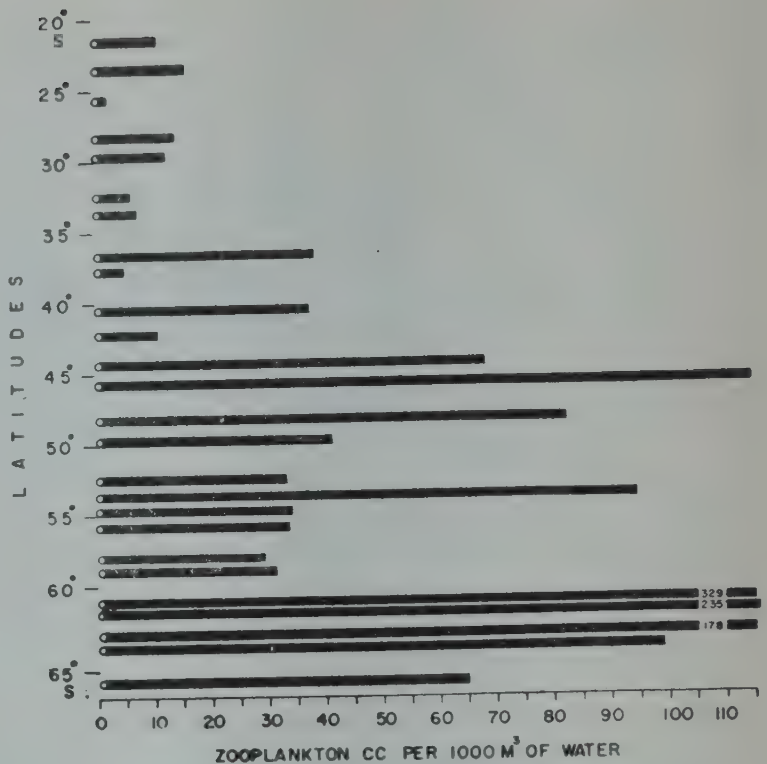


Fig. 15. The latitudinal abundance of zooplankton between Antarctica and Mauritius

Table 1. *Sampling details and displacement volume of zooplankton and the occurrence and abundance of krill in collections made for the geographical distribution*

Gear : Bongo-60 Wire paid out : 150m Type of haul : Oblique

No.	Date	Time (hr)	Position Lat°S	Position Long.°E	D. stn. (m)	Zoopln. ml/1000 m³ of water	% of euphau slids in pln.	*Krill* No/1000 m³ of water
1.	2–3–'84	1100	68°30'	14°00'	3528	20.95	0.92	136
2.	2–3–'84	1730	68°30'	15°00'	3739	36.53	0.29	50
3.	2–3–'84	2030	68°30'	16°00'	3484	38.49	30.43	171
4.	2–3–'84	2340	68°30'	17°00'	3710	185.13	12.11	148
5.	3–3–'84	0240	68°30'	18°00'	3982	96.12	4.45	307
6.	3–3–'84	0600	68°30'	19°00'	4163	25.42	51.78	89
7.	3–3–'84	1335	68°30'	20°00'	3801	41.29	7.92	237
8.	3–3–'84	1645	68°00'	20°00'	4072	63.44	6.28	194
9.	3–3–'84	1855	68°00'	19°00'	4163	45.51	4.24	10
10.	3–3–'84	2140	68°00'	18°00'	4163	107.85	0.25	116
11.	4–3–'84	0045	68°00'	17°00'	3891	216.35	2.26	240
12.	4–3–'84	0445	68°00'	16°00'	3800	91.66	0.63	316
13.	4–3–'84	0800	68°00'	15°00'	3759	134.91	0.19	115
14.	4–3–'84	1100	68°00'	14°00'	3077	116.53	0.21	118
15.	4–3–'84	1515	67°30'	14°00'	3352	142.15	1.60	1032
16.	4–3–'84	1730	67°30'	15°00'	2996	248.83	0.27	337
17.	4–3–'84	2000	67°30'	16°00'	4072	54.57	0.50	124
18.	4–3–'84	2230	67°30'	17°00'	4525	119.95	11.07	132
19.	5–3–'84	0100	67°30'	18°00'	4344	188.69	5.49	78
20.	5–3–'84	0400	67°30'	19°00'	4549	32.30	0.31	46
21.	5–3–'84	0655	67°30'	20°00'	4254	74.62	0.58	195

5. **Latitudinal distribution of euphausiids and other zooplankton in the southern ocean between Antarctica and Mauritius**

In order to study the latitudinal limits in the occurrence and abundance of various species of euphausiids (the group of organisms to which the 'krill' belongs) and other zooplankters a series of samples were collected using a Bongo–60 net starting from 68°30′S at an average of 1.5 degree interval upto Mauritius. The total zooplankton obtained from the different latitudinal stations is presented in Fig. 15.

III. Observations made on sea birds of the southern hemisphere

During the course of the Expedition, observations were made by the author on the sea birds of the southern ocean between Mauritius and Antarctica. Sharp limits in the distributional range of species of birds were noticed in most of the cases. While birds of some species have fairly wide geographical range others were found restricted to very narrow latitudinal ranges. On some occasions some species of birds landed on the deck of the ship either for taking rest or after hitting against the communication antennae of the ship.

Broadly, the species identified can be divided into two categories, the birds observed enroute and those found in Antarctica. As a result of the observations 30 species of birds belonging to 22 genera and seven families have been identified. Of these birds eight species were noticed in the sea near the shelf ice.

Methods

A binocular of the power of 50x30 was used for watching the birds. They were watched in flight and some

Table 2. *Geographical range of birds observed with dates of observation and number of birds observed*

Sl. No.	Species	Period	Latitudinal range (S)	No. of birds
1.	Great-winged Petrel	9–12–83	13°50' – 16°07'	4
2.	Sooty Tern	9–12–83 to 10–12–83	13°50' – 19°18'	ca 500
3.	Brown Noody	10–12–83	19°00' – 19°18'	150
4.	Wandering Albatross	16–12–83 to 22–12–83	29°14' – 54°17'	14
5.	Soft-plumaged Petrel	17–12–83 to 18–12–83	35°00' – 41°00'	6
6.	Dove Prion	18–12–83	40°00' – 41°00'	100s
7.	Sooty Albatross	18–12–83 to 19–12–83	40°00' – 45°17'	5
8.	Northern Giant Petrel	18–12–83 to 19–12–83	40°00' – 45°17'	4
9.	Black-browed Albatross	18–12–83 to 19–12–83	40°00' – 45°17'	2
10.	Grey-headed Albatross	18–12–83 to 23–12–83	40°00' – 57°19'	12
11.	White-chinned Petrel	18–12–83 to 23–12–83	40°00' – 57°19'	6
12.	Black-bellied Storm Petrel	19–12–83	42°30' – 47°17'	1
13.	White-headed Petrel	19–12–83 to 22–12–83	42°30' – 54°17'	8
14.	Grey-backed Storm Petrel	19–12–83 to 20–12–83	42°30' – 49°39'	22
15.	Light-mantled Sooty Albatross	19–12–83 to 23–12–83	42°30' – 57°19'	4
16.	Thin-billed Prion	19–12–83 to 24–12–83	42°30' – 61°12'	100s
17.	Kerguelen Petrel	20–12–83	48°00' – 49°39'	1
18.	Broad-billed Prion	20–12–83 to 22–12–83	48°00' – 54°17'	50
19.	Common Diving Petrel	20–12–83 to 24–12–83	48°00' – 61°12'	8
20.	*Cape Pigeon	21–12–83 to 1– 3–84	52°06' – 69°30'	50
21.	Blue Petrel	23–12–83	56°05' – 57°19'	1
22.	Thick-billed Prion	23–12–83	59°38' – 61°12'	1
23.	Southern Giant Petrel	23–12–83 to 25–12–83	59°38' – 61°12'	26
24.	*Snow Petrel	25–12–83 to 1– 3–84	63°27' – 70°01'	100s
25.	*Antarctic Petrel	25–12–83 to 1– 3–84	63°27' – 70°01'	100s
26.	*Emperor Penguin	26–12–83 to 28–12–83	68°16' – 69°58'	3
27.	*Adelie Penguin	26–12–83 to 1– 3–84	68°16' – 70°01'	200
28.	*Southern Antarctic Skua	27–12–83 to 1– 3–84	68°58' – 70°46'	25
29.	*Southern Fulmar	28–12–83 to 1– 3–84	69°58' – 70°01'	15
30.	*Wilson's Storm Petrel	28–12–83 to 1– 3–84	68°58' – 70°01'	10

*The birds found on the Antarctic continent and in the adjacent sea.

of them while resting or swimming in water. The identification of the species was done based on structure of body, colour of plumage, patterns of colour, flight characteristics, structure and colour of beak, and other similar characters. Table 2 gives the list of the sea birds watched along with their observed geographical range.

Recommendations for 'Krill' Research and Exploitation

1. 'Krill' being the first antarctic resource which India can think of exploiting in the near future, immediate attention may be paid for the development of scientific and technical expertise and infrastructure for an early achievement of this goal.

2. In the proposed Indian Antarctic Research Institute, maximum priority may be given for the research and exploitation of 'krill'.

3. Personnel may be trained in locating and catching of 'krill', in countries which are engaged in krilling at present.

4. The ship, that India is proposing to acquire for Antarctic research, should have facilities for the catching, processing, packing and storing of 'krill' and 'krill' products.

5. Intensive surveys using modern 'krill' finding sonars, and sampling over vast geographical areas within the Antarctic convergence have to be carried out for the location of 'krill' swarms.

6. Special sonars for the detection of 'krill' swarms are required on board the ship. Also all facilities (winches, trawls etc.) for catching of 'krill' are needed on board the ship.

7. For carrying out marine research and investigations on 'krill' and other living and non-living resources of the southern oceans, 'Antarctic Support Cruises' may be organised deploying additional vessels that can go upto the Antarctic Circle.

8. Side by side with the exploration and exploitation of 'krill' resources, processing technologies to make suitable for human consumption, food for cattle and poultry or for using in aquaculture, may be developed at the concerned Institutes.

9. One expedition exclusively for marine research may be organised for a better understanding of the ecology and biology of the polar seas in which India has interest. Most of the samplings are to be carried out during the summer months and towards the beginning of the winter.

I am extremely thankful to Dr. E. G. Silas, Director, CMFRI, for nominating me for participating in the Expedition and also for providing all kinds of help for the successful completion of the work assigned to me. My thanks are also due to the Department of Ocean Development for giving me an opportunity to go to Antarctica and carry out my investigations there. The help rendered by Shri D. Vincent, Technical Assistant of the Institute in analysing the zooplankton samples is gratefully acknowledged.

A research vessel from Goa yard

The *Matsya Vishwa* a deep sea exploratory fishing vessel of 36.37 m built at the Goa Ship Yard has been delivered to the Ministry of Agriculture. This is the 6th and last vessel of the series the yard has built under the Indo-Norwegian Programme. The vessel is equipped for bottom and pelagic trawling and for long lining. Fitted with equipments for oceanographic surveys, an autopilot, electromagnetic log, radar, magnetic and gyro compasses and satellite navigator the ship can be out in the sea for 22 days.

Plywood fishing crafts in big demand

In view of the scarcity of wooden logs for making dugout canoes and 'cattamarans', cheap and alternative material for building fishing canoes are under test. Using good quality Indian plywood, two British firms have designed and made canoes based on stitch and glue technique. In costs these boats are comparable to traditional boats but in performance they have proved superior. The handling problems of the boats are comparatively less. More than 100 of such boats are in use in Kerala and Tamilnadu.

Fishing News International 23 (12) 1984.

Spanish interests on Indian Ocean tunas

Under an agreement with the Republic of Seychelles 15 Spanish tuna ships are to be allowed to operate in the waters of the Indian Ocean archipelago. This further strengthens the movement of Spanish fishing activity into the Indian Ocean. A fishing agreement has already been reached with Mozambique. Further arrangements are being done with Maldives, Tanzania and Madagascar.

Fishing News International 22 (12) 1983.

Breakthrough in processing krill

Machinery for peeling krill for human consumption has been developed in Poland. The technology makes it possible to obtain the product with nearly nil content of chitin. The taste of krill peeled in this way is similar to the taste of shrimp.

Fishing News International 22 (12) 1983.

Extend shelf life of fish by irradiation

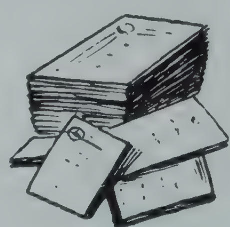
Hopes for extending the shelf-life of fiish are now centred on irradiation. This controversial method of processing food products is arousing interest in many countries. Practical application of food irradiation processing including sea food is going on in countries such as Belgium, Japan, Netherlands and South Africa. As a processing technique irradiation could help to produce a safer product. Low dose irradiation would be effective in fish as a means of insect disinfestation. Gamma rays are also effective in eliminating *Salmonella* in human consumption fish as well as fish meal in the final packing.

Fishing News International 22 (12) 1983.

Fish catch to be doubled by the turn of the century

World food fish supplies will need to be doubled by the year 2000 to meet estimated consumption needs, says F A O Director General, Edouard Saouma. This is required to maintain per capita consumption rate at present world levels. However, he feels that this target will be difficult to meet as the world production of fish is growing by only about 1% a year. Therefore, the challenge is to find out additional fish which would require much more than an improvement in present fishery practices. Along with finding out additional fish, we must make better use once it has been harvested. He proposes an all out war on waste, noting that some 10% of the world catch is lost through spoilage. More is being wasted through dumping back into the sea in operation such as shrimp trawling. He also urges industry to find ways of diverting to direct human consumption a major part of 20 million tons of fish converted each year to animal feed.

Fishing News International 22 (11) 1983.



Compiled and prepared by M. J. George, K. J. Mathew, G. Nandakumar & Jancy Jacob
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MARINE FISHERIES INFORMATION SERVICE

No. 58
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1984

Technical and Extension Series

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

COCHIN, INDIA

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the National Marine Living Resources Data Centre (NMLRDC) and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

Abbreviation – *Mar. Fish. Infor. Ser. T & E Ser.*, No. 58: 1984

CONTENTS

Cover photo: Clam deposits collected from the Kali river accumulated at Sadashivgad

MOLLUSCAN RESOURCES OF KALI RIVER ESTUARINE SYSTEM IN KARNATAKA

K. NAGAPPAN NAIR, K. RAMADOSS AND C. T. RAJAN

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Introduction

The Kali river in Karnataka is well known for edible molluscan resources but there have been no detailed studies on the resources of the river except for the works of Rai *(J. Bomb. nat. Hist. Soc.*, 35 (4): 826-47, 1932) and Alagarswami and Narasimham (*Proc. Symp. Living Resources of the seas around India*, CMFRI: 648-58, 1973) who have made some observations on the resources in the river and their exploitation. Available information on the clam and oyster resources of the Kali river is of a generalised nature and it has been felt that there is need for a detailed survey of the river which supports a regular molluscan fishery. A survey of the Kali river was considered by the Central Marine Fisheries Research Institute on account of a dispute arising between the clam fishermen of the Kali river and the industry exploiting shell deposits. It was felt that first hand assessment of the conditions would help to evaluate the status of the live clam resources from the river bed. During the survey conducted in November–December, 1978 observations were made on the environmental conditions, species composition of the molluscan resources, their distribution pattern, exploitation and marketing and the findings are presented in this paper.

Physiography of Kali river

The Kali river is an important perennial river of Karnataka which joins the sea at the northern border of Karwar at lat. 14°48′ N and long. 74°8′ E (Fig. 1). Some islets are present in different parts of the river from a distance of 2 km from its mouth. There are also submerged rocks upstream beyond a distance of 7 km from the mouth. The water depth varied from less than 1 m to 7.75 m and at a number of places near the banks of the river it was ankle deep enabling fishermen to collect clams found there easily. Strong currents occur in the river especially at low tide.

Method of survey

The river was surveyed from the river mouth upstream up to Mallapur, the limit up to which molluscan resources are available in the river bed. The survey was planned in such a way that a certain spot on the southern bank of the river was taken as the base and the river bed was extensively sampled breadthwise along a straight line towards the northern bank. Samples were collected at a distance of every 200 m between the banks. The width of the river varies much. It is 0.4 km at the mouth and a maximum of 1 km at other places, for example at Nandangadda. A quadrat frame of 0.5 x 0.5 m was made use of for sampling the river bed (Fig. 2). To prevent the frame from moving due to water current, it was provided with sharp, pointed wooden pegs at the four corners so that it could be placed over the sampling area by driving the wooden pegs into the sand. After fixing the quadrat repeated skin divings were made quickly to scoop out the sand and mud up to a depth of 25 cm from the sampling area. Later the molluscan species found in the samples were separated. At each sampling station particular attention was paid to observe the nature of bottom, depth of water in the sampling area, species composition, density of population per m^2, size range of the species and percentage of live and dead shellfish.

From the river mouth to Mallapur, totally 12 bases viz., river mouth, Kodibag, Nandangadda, Sunkeri, Kadwad, Ambeju, Bhairebag, Kinnar, Botjug, Kerwad, Irpagae and Mallapur extending over a distance of 18 km were selected along the southern bank of the river for observations. The data collected from different parts

Fig. 1. Map showing important clam and oyster fishing villages along Kali river.

of each base were pooled together and the average was worked out for the density of population. The size range of individual species was also noted. The average depth was determined, water samples were collected and salinity, dissolved oxygen and pH were determined at each base.

Observations and results

Hydrographic conditions in Kali River

Generally the salinity of the Kali river fluctuates in different areas with the tides. At Kodibag which is near the mouth of the river, the salinity was high, 33.44‰ at high tide and decreased to 21.65‰ at low tide (Table 1). The salinity values at Sunkeri and Kadwad further upstream in the river were comparatively less than at Kodibag being 30.82‰ and 28.85‰ respectively. At Sunkeri a decline in salinity to 18.15‰ was noticeable at low tide. At Kinnar which is 8 km from the river mouth salinity was very low, 8.76‰ and the values in the bases further up showed progressive reduction and at Mallapur it was 0.24‰. In the bases in the upper reaches there was further fall in salinity at low tides.

The dissolved oxygen varied over a limited range of 3.18–3.73 ml/1 at the various bases at high tide and the values were slightly higher at low tide. The pH fluctuated between 8.2 and 8.4 in Kodibag–Kadwad area at high tide and it was 7.0–7.4 in Kinnar-Mallapur area. A fall in pH was evident in the Kodibag–Nandangadda area at the time of low tide.

Distribution of clams and oysters

The survey has brought to light a vast clam bed which extends from the river mouth to a distance of 18 km upstream up to Mallapur. The clam resources comprise of three species *Meretrix meretrix, Paphia malabarica* and *Villorita cyprinoides*. Locally the large clams *M. meretrix* and *P. malabarica* are called *Kube* and *Tisra* respectively. *V. cyprinoides* is also known as *Kube*. Two species of oysters *Crassostrea madrasen-*

Table 1. *Hydrographic conditions during November-December 1978 at different bases of survey in Kali river, Karnataka*

Area		Nature of bottom	Average depth in m	Salinity (‰)		Dissolved oxygen (ml/l)		pH	
				At high tide	At low tide	At high tide	At low tide	At high tide	At low tide
River mouth		Sandy	4.5						
	N	Muddy, rocky							
Kodibag	M	Muddy							
	S	Coarse sand	3.0	33.44	21.65	3.18	3.73	8.4	7.2
	N	Hard substratum, sandy, rocky							
Nandangadda	M	Sandy	2.0						
	S	Muddy							
	N	Sand with mud, rocky							
Sunkeri	M	Sandy	2.0	30.82	18.15	3.18	3.73	8.2	7.4
	S	Sandy, rocky							
Kadwad	N	Muddy, rocky							
	M	Sandy	1.75	28.85		3.59		8.4	
	S	Muddy, rocky							
	N	Sandy							
Ambeju	M	Sandy, rocky	1.50						
	S	Sandy, muddy							
	N	Sandy, rocky							
Bhairebag	M	Coarse sand	1.50						
	S	Sandy							
	N	Sandy							
Kinnar	M	Coarse sand	1.60	8.76	7.45	3.59	3.73	7.4	7.2
	S	Black clay, muddy							
	N	muddy							
Botjug	M	Sandy	1.50	5.70	4.83	3.73	4.01	7.2	7.2
	S	Sandy							
	N	Sandy							
Kerwad	M	Coarse sand	7.75	2.43		3.73		7.2	
	S	Muddy							
	N	Sandy							
Irpagae	M	Muddy	1.50	0.46		3.46		7.0	
	S	Muddy							
	N	Sandy							
Mallapur	M	Sandy	1.50	0.24	0.24	3.73	3.73	7.0	7.0
	S	Rocky							

N-North, M-middle and S-South portions of transects.

sis and *Saccostrea cucullata* have veen recorded from the river. The oysters are known locally as *Kaloo*.

M. meretrix is the dominant species and occurs at a depth of 1 m or less from Nandangadda to Kinnar with clams in densities of 4–160/m^2 from Nandangadda to Kinnar (Table 2). In this area the substratum is predominantly sandy with a little mud which appears to be most ideal for this species to settle and grow. The size range of the clams found at Bhairebag and Kinnar which are 7-8 km from the mouth of the river is 7–17 mm On the other hand the size of clams in the downstream areas Nandangadda to Ambeju varied from 19 mm to 48 mm. This suggests that the clams of smaller

Table 2. *Density and size range of bivalves occurring in different bases in Kali river*

Area	*Meretrix meretrix*			*Paphia malabarica*			*Villorita cyprinoides*			Edible oysters		
	Average density per m²			Average density per m²			Average density per m²			Average density per m²		
	Live	Dead	Size range (mm)	Live	Dead	Size range (mm)	Live	Dead	Size range (mm)	Live	Dead	Size range (mm)
River mouth		10		4		20–31					20	80–120
Kodibag		20		10		22–33				2	15	80–120
Nandangadda	4	80	30–38	120	20	25–34				10	10	70–100
Sunkeri	130	2	33–36							15	20	80–150
Kadwad	140	16	31–48							3	25	80–150
Ambeju	150	15	19–27							4	42	90–120
Bhairebag	160	20	14–17							2	35	90–120
Kinnar	120	25	7–14							2	40	90–120
Botjug							120		22–36			
Kerwad							80		16–34			
Irpagae							52	8	18–35			
Mallapur							4		20–28			

sizes prefer the upstream areas. Dead shells of this species occurred in densities of 2–80/m² from river mouth up to Kinnar.

P. malabarica is found from river mouth up to Nandangadda only and it is common in the latter area with an average density of 120/m². This species is distributed in the deeper parts of the river where the depth is 2–3 m and ranges in size from 20 to 34 mm.

From Kinnar onwards at different places like Botjug, Kerwad and Irpagae up to Mallapur the black clam *V. cyprinoides* is the only clam species met with. This species occurs over a wide depth range of less than 1 m to 7.5 m at Kerwad. The average density of this species is 120/m², at Botjug and it progressively decreases in the upstream areas reaching a density of 4/m² at Mallapur. *V. cyprinoides* is distributed in the upper parts of the river only between Kinnar and Mallapur where the salinity is very low being 0.24‰–8.76‰ even at high tides. Beyond Mallapur upstream the river bed is predominantly rocky and no clams are encountered.

The rock oyster *S. cucullata* is found in small numbers of 10–20/m², on the surface of rocks in intertidal zone at Sunkeri (Fig. 3), Kadwad and Ambeju. In these areas *C. madrasensis* is also found in clusters in densities of 3–15/m², attached to discarded oyster shells at a depth of 1–2 m. Dead oysters were noticed from the river mouth up to Kinnar. In and around Kodibag which is about 2 km from the mouth of the river live oysters are very few, but further upstream they are comparatively more common as at Nandangadda and Sunkeri (Table 2). The oysters are found attached to rocks at Nandangadda while at Sunkeri they settle on oyster shells thrown into the river by fishermen after scooping out oyster meat. Beyond Sunkeri up to Kinnar, oysters occur in very low densities on rocky or firm sandy muddy substratum.

Clam and oyster fisheries

Both clam and oyster resources of the Kali river are exploited. The clam fishery of the river is a very important one and a large number of fisherfolk are engaged in the fishery while the oyster fishery is a localised one and restricted to Sunkeri. The fisherfolk of the villages on both the northern and southern banks of the river are engaged in clam fishing. The main clam fishing centres are Kodibag, Nandangadda, Sunkeri, Kinnar and Kadwad on the southern bank and Sadasivagad, and Kanesgiri on the northern bank. The fisherfolk belong to Harkantra, Gabbit, Konkanagarvi, Ambitta, Dlathi, Bhovi and Bandari communities. Of these, persons of the Gabbit community are exclusively engaged in clam fishing. Although more than 25,000 fisherfolk in total are living in these villages

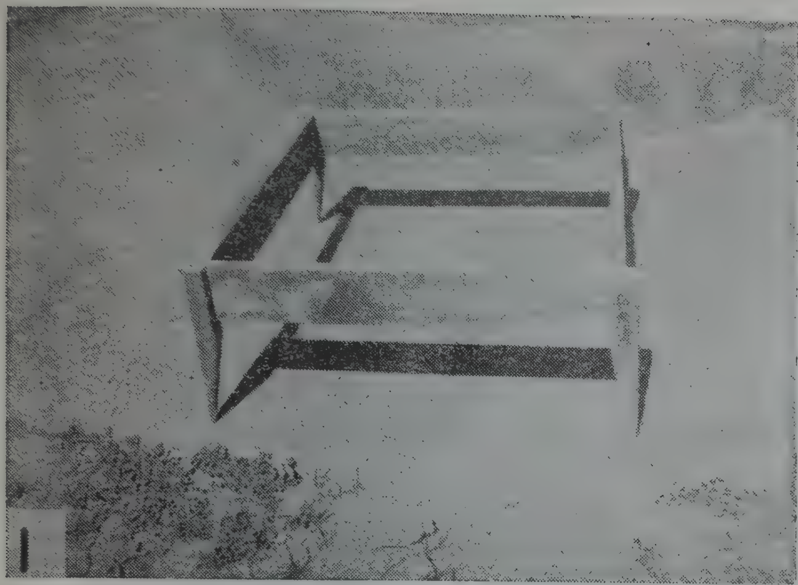
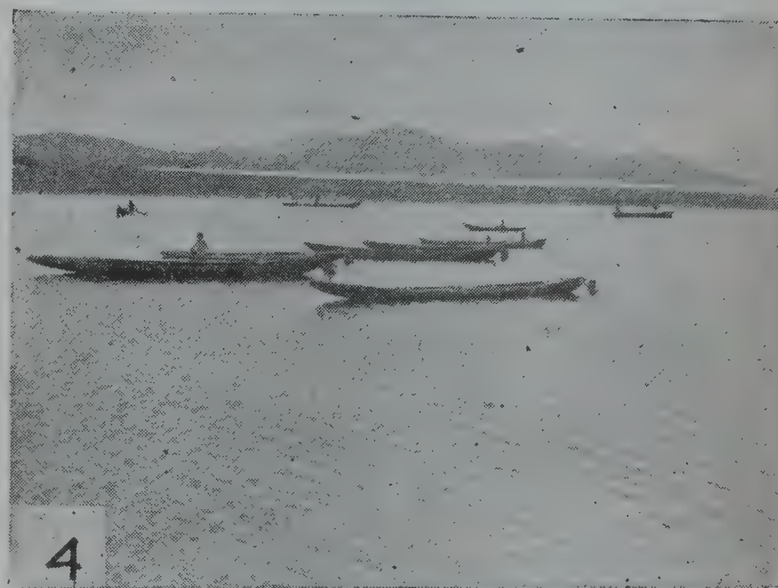


Fig. 2. Wooden quadrat used for sampling bivalves.

Fig. 3. Rock oysters, *Saccostrea cucullata* at Sunkeri.



Figs. 4 and 5. Clam fishing using boats and nets at Sunkeri.

Fig. 6. Fisherwomen gathering clams by hand-picking at Sunkeri.

Fig. 7. Clam fishing net.

Fig. 8. Dredge used for collecting bivalve shells from the subfossil deposits of Kali river.

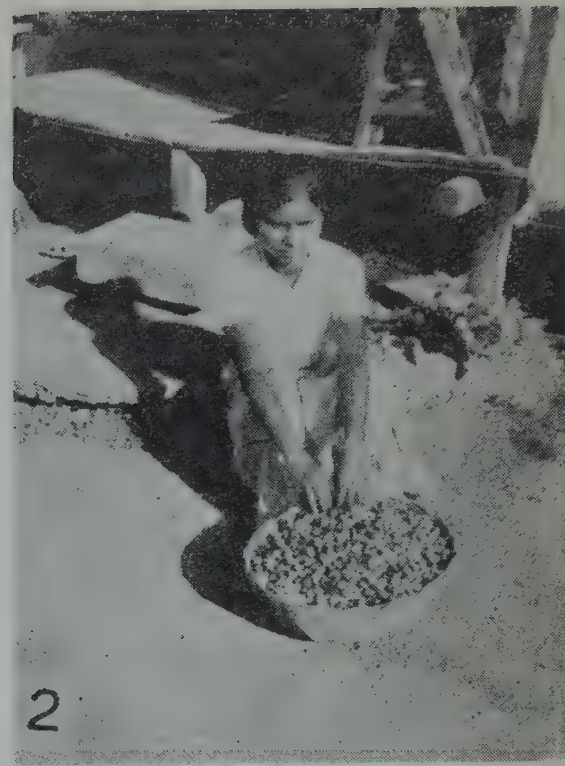


Fig. 9. A fisherwoman with clams ready for sale.

Fig. 10. Dredging operation for empty shells.

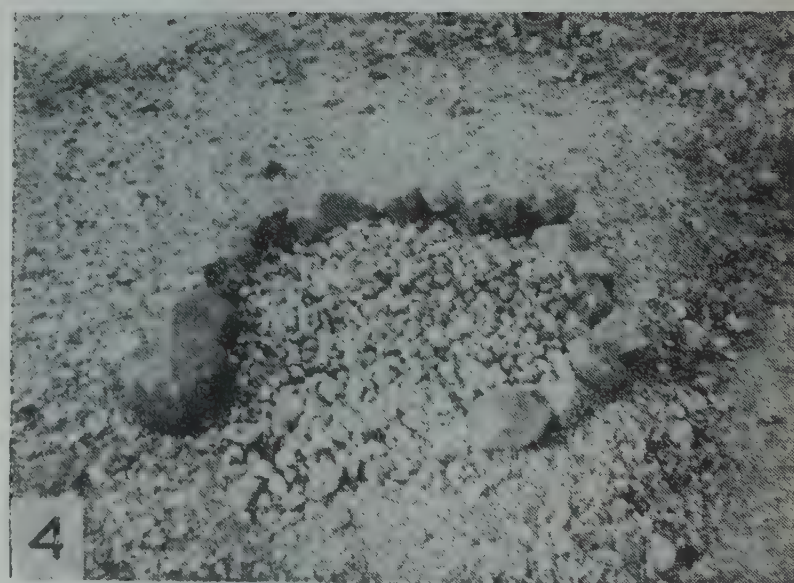


Fig. 11. Clams kept in sheltered tidal area.

Fig. 12. Heaps of shells with sieving device.

Fig. 13. A close-up view of shells gathered for industrial uses.

along Kali river, on an average only about 500 individuals including men, women and children fish for clams in the river every day. Fishing is carried out throughout the year unless there is a heavy flood in the river as during the southwest monsoon months.

Clam fishing is done during low tides irrespective of the time of the day. Hand-picking (Fig. 6) is the common method of fishing for the large clam *Meretrix meretrix* although nets are used sometimes in areas where the clams are found in large numbers. In deeper zones of the river the bottom is ploughed with leg and individual clams are collected as in Sunkeri area. When a large number of clams are encountered, a clam fishing net called *Kambalai* (Fig. 7) is used (Figs. 4 & 5). The net is held in position with one leg over the river bed while the clams along with sand and debris are pushed into the net with the other leg. After repeated operations for sometime, the net is lifted, the sand allowed to pass through the meshes and clams are collected and stored in boat. In some areas in and around Sunkeri and Kadwad during low tide, the bed is completely exposed and clams are handpicked from such areas. Intensive fishing for *Meretrix meretrix* is done in areas from Sunkeri to Kinnar.

In the case of fishing for *Paphia malabarica* the boat is kept in position with the help of a bamboo pole since the clams have to be collected from deeper areas with depths of 2–3 m. (Figs. 4 & 5) Due to the occurrence of clams together in large numbers, a net is frequently used. On an average about 75 boats are employed per day for *Paphia* fishing. Empty shells of *Paphia* are also collected in the net. When compared to other molluscan species, empty shells of *Paphia* are encountered in more numbers and form almost half of the quantity of the live clams. Irrespective of the species, the empty shells are invariably left on the river bed.

Clams are kept in the intertidal areas in small enclosures made with stones (Fig. 11) and are thus safely stocked for two or even three days before marketing. Usually the clams collected are stocked for at least one day before they are marketed. Rough estimates made of clam landings of Kali river indicate an annual clam production of about 2,000 t. *Crassostrea madrasensis* occurring in the river bed at a depth of 1–2 m at Sunkeri are collected by fishermen by diving at low tides. The oysters gathered are either sold or consumed by the fishermen.

In addition to the fishing of live clams and oysters, sub-soil molluscan shell deposits mostly clams present in the river bed are exploited on a large scale by agents of companies manufacturing calcium carbonate, caustic soda and fertilizers. (Table 3). The State Department of Geology leases out the right of collection of empty shells from the Kali river bed on a long term basis. The particulars of the companies etc. who acquired the rights of lease are given in Table 3. The clam shells are collected by the lessees from the river bed by operating a kind of a dredge consisting of an iron frame, with a net and provided with a long iron handle. The dredge could be operated at a depth of 2–4 m (Figs. 8 & 10).

When it is dragged on the bottom of the river where shell deposits are present, the shells are collected along with sand and debris. After washing the shells in the water the dredge is lifted and shells taken into the boat. On making trial operations of the dredge to assess the effect of dredging on live clams, it was found that near the banks of the river clam shells alone were collected

Table 3. *Details of leases for exploiting sub-fossil shell deposits in Kali river, Karnataka*

Name of lessee	Area and extent sanctioned		Date of sanction	Period
M/s. Mineral Enterprises (P) Ltd., Karwar	Kodibag	403.23 ha	11–7–1972	21 years
–do–	Chittakula	110.50 ha	3–1–1976	–do–
Shri M. Mohammed Ismail	Kadwad & Kinnar	132.52 ha	28–6–1976	–do–
M/s. Mangala Minerals	–do–	–do–	20–10–1976	–do–
M/s. West Coast Paper Mills Ltd.	Sunkeri	151.71 ha	14–12–1976	–do–
M/s. Mangala Minerals	Kali river creek		1–6–1978	10 years

in it whereas in deeper areas good numbers of live clams were got along with dead ones. The dredged shells are allowed to dry, sieved and accumulated in large quantities for the use of industries (Figs. 12 & 13.)

Marketing of clams

Clams are regularly sold in the local markets. They are taken to the markets by womenfolk in head-loads and sold throughout the day. The clams are marketed with shells intact (Fig. 9) while the oysters are shucked and meat sold. The market price of the large clam *M. meretrix* depending on the size varies from 30 paise to 65 paise per 100 numbers whereas *Paphia malabarica* is sold at the rate of 30 paise per 100 numbers. The prices of shucked oysters is higher and they are sold at Rs. 4–6 per 100 numbers. Normally the marketable size of *M. meretrix* varies from 30 to 48 mm, that of *P. malabarica* from 20 to 34 mm and oysters from 90 to 120 mm in size. Both clams and oysters are packed in wet gunny bags and sent in vans to distant places like Goa and Bombay where they find a ready market. People living in and around the villages situated on the banks of the river in upper reaches, who are mainly agriculturists barter clams for paddy. One measure of clams irrespective of size fetches equal quantity of paddy. At times, clam and oyster meat is also sun-dried and marketed.

Discussion

The present work has shown that there is an organised clam fishery for *Meretrix meretrix, Paphia malabarica* and *Villorita cyprinoides* in Kali river. The three species of clams show differential distribution. *Paphia malabarica* is confined to lower reaches of river from the river mouth to Nandangadda where salinity is 33.44‰ suggesting that this species has distinct preference for areas where salinity is high. In a study of benthos of Kali river, Harkantra (*Mahasagar* 8 (1 & 2): 53-58, 1975) has also made similar observations on this species. *Meretrix meretrix* occurs over a distance of 6.25 km from Nandangadda where the salinity is 30.82‰ to Kinnar where the salinity is 8.76‰. *Villorita cyprinoides* is distributed only in low salinity areas in the upper parts of the river from Botjug to Mallapur where salinity is uniformly low fluctuating between 5.7‰ and 0.24‰ indicating that this species thrives well in low salinity conditions.

Although large quantities of clams are caught from the river, there is no information on the annual production, seasonal variations in landings and biological characteristics of the species exploited. Studies on these aspects will be helpful for proper management of the fishery. There are many large shallow stretches in the Kali river where it may be possible to transplant seed clams and carry out clam farming. The possibilities for conducting clam farming in the river could be explored as production from clam farming operations could augment that from capture fishery in the river. There is a very large demand for clam meat in several countries. India has exported as much as 510 t of clam meat during 1982–83. By stepping up clam production from Kali river, there are very good possibilities to meet the demands of export industry.

In the exploitation of the subfossil shell deposits in the Kali river, there appears to have been indiscriminate capture of live clams, belonging to the species *Meretrix meretrix* and *Paphia malabarica* in large numbers, which is detrimental to the resources. According to the local clam fishermen, dredging operations have been carried out by the agents of industries over wide areas in the river bed.

Due to the intensive quarrying carried out in these areas the topography of the river bed has changed much rendering survival of clam populations difficult. Therefore it is suggested that areas where subfossil deposits are distributed should be clearly demarcated through detailed geological investigations and the State Government has to prevent indiscriminate capture of the live clams by regular inspection of the quarrying of shell deposits.

We wish to express our gratitude to Dr. E. G. Silas, Director, Central Marine Fisheries Research Institute, for the kind encouragement received from him. We are thankful to Dr. K. Alagarswami, Head of Molluscan Fisheries Division, CMFR Institute for critically reading the paper and giving helpful suggestions and to Dr. M. V. Pai, the then Officer-in-charge, Karwar Research Centre of CMFR Institute, for extending all facilities and help to us during the course of this investigation. Our thanks are also due to Shri Shankar, Supporting Staff, for assisting in the field work.

MULTIDISCIPLINARY MARINE FISHERIES RESOURCES MANAGEMENT*

World fisheries have been beset by problems such as the over exploitation of resources, a restricted approach to fisheries problems, marine pollution and the establishment of exclusive economic zones. The purpose of this paper is to present a summary of a modern, logical and systematic multidisciplinary approach to fisheries management for administrators, the details of which are available elsewhere (Bakus, in press).

The major objectives of a fisheries resources management programme are to: 1) summarize existing information of fisheries; 2) emphasize data gaps for priority species; 3) assess socioeconomic problems and user conflicts, 4) develop a comprehensive management programme. How these objectives can be reached is accomplished by carrying out a seven phase programme.

Phase I (Initial Contact and Information Gathering) begins by the formation of a working group of experts, comprising at least a programme manager, fishery biologist, fishing industry specialist, economist, sociologist and in some cases a pollution or public health specialist. These individuals compile, with the help of students, preliminary data and information in their respective

Table 1. *Species Information Sheet*†

Species:
Distribution:
Habitat Preference:
Abundance:
Reproduction:
Production:
Ecology:
Feeding Habits:
Predators:
Disease:
Other Related Data: (e. g., physiology)
Commercial Harvesting:
Sport and Recreational Harvesting:
Subsistence-Artisanal Harvesting:
Legal Aspects:
Alternative Species for Exploitation:
Fishing Regulations:
Methods of Processing:
Economics of Processing:
Marketing of Fish:
Sociology-Anthropology:
Additional Information:

†Detailed descriptions are presented in Bakus (in press)

Table 2. *Fisheries Resource Management Programme Methodology*

Preliminary investigation	Intensive field study	Laboratory studies and data analysis	Group analysis	Results
Initial Contact-Information Gathering	Ecology	Ecology	Progress Meetings	Summary of Information on Priority Economic Species
Formation of Working Groups	Fisheries Biology and Management	Fisheries Biology and Management	Modelling	Data Gaps
Information Compilation	Economics	Economics	Feedback and Evaluation	Recommended Research Programmes
Information Synthesis	Sociology	Sociology	Decision Analysis	Alternative Management Plans
General Meetings	Pollution and Health	Pollution and Health	...	Preferred Management Plans including Cost-benefits, Tradeoffs & Management Priorities in Rank Order of Importance

*Prepared by Gerald J. Bakus, Department of Biological Sciences, Universiry of Southern California, Los Angeles, California 90089–0371, U. S. A.

disciplines from a variety of sources. Phase II (Information Compilation) is a more intensive compilation of published and unpublished materials, including the use of computer searches of the literature if feasible. Information obtained in Phase II is synthesized in Phase III (Information Synthesis). These synthesized data are entered into data sheets, a separate set for each priority species (Table 1). Data gaps are ranked into three categories: essential, important, and minor importance, providing the government and others with suggested priority research programmes.

Phase IV (Preliminary Research) is an attempt to fill serious data gaps prior to the development of alternative management plans. Phase V (Modelling) consists of the development of visual or compartmental models, both general and specific, in order to help the working group understand more clearly the inter-relationships between the various parts of the management framework. Models for stock assessment are also considered at this time. A series of alternative management scenarios are developed in Phase VI (Management Scenarios) that reflect a variety of interests.

Phase VII (Final Management Plan) incorporates a powerful decision making procedure (multi-attribute utility measurement) to select the best management alternative. This process consists of first rating each attribute (e.g., fishermen's net income) on a scale of 0 to 100 against each alternative management plan, followed by the ranking of the attributes (e.g., fishermen's net income vs. fish stock assessment vs. coliform counts in fish, etc.), to give a final composite score that ranges from 0 (worst) to 100 (best) (Bakus, 1983, *Oceau Mgmt.* 8: 305-316). The management plan with the highest score is recommended along with alternative plans, in rank order of importance. The management plan summarizes all probable costs and benefits, tradeoffs, and recommended major research, development, and management priorities in rank order of importance. This methodology is summarized in Table 2.

REGULATED MECHANISED AND TRADITIONAL FISHING IN TAMILNADU — AN APPROACH TO END CLASHES*

Introduction

Marine fishing in India is generally confined to narrow regions of nearshore areas. Till fifties marine fishing mostly by indigenous craft was in vogue throughout the Indian coast. Inspite of successful experimental fishing of small mechanised boats introduced by Indo-Norwegian Project, mechanised fishing could not take strong roots till the end of sixties. Entering into prawn export trade was the turning point in the annals of fishing history of India and the enticing returns from exportable varieties encouraged introduction of mechanised boats on a large scale. This has brought in a new set of man power generally not drawn from traditional fishing communities. The presence of mechanised boats operated by those who were not involved in fishing earlier and the encroaching of the inshore fishing grounds by these boats created conflicts between the traditional and mechanised sectors, resulting in clashes between these two sectors leading to large scale damages to both men and material. In order to save marine fishery from such a set back, different schemes are being introduced in different areas. One such novel scheme introduced in Tamil Nadu is described in the following.

The coast from Jagathapattinam (south) in Pudukkottai District to Mallipattinam (north) in Thanjavur District (Fig. 1) consists of 26 marine fish landing centres, 10 in the district of Pudukkottai and the rest in Thanjavur. Unlike the other regions in the east coast, the sea-front here is shallow and most of the time in the year this area is very calm and accessible for fishing by all types of gears. The operation of catamarans is significantly low in this stretch. This coastal region is a rich ground for important fisheries such as prawns, silverbellies otherwise locally called "KAARAL", sciaenids, pomfrets, seer fish and crabs. To exploit good grounds of prawns, mechanised fishing has been intensified in this area since past five years. The important mechanised fishing centres are Jagathapattinam, Kottapattinam, Sethubavachatram and Mallipattinam.

*Prepared by G. Balakrishnan and K. Alagaraja

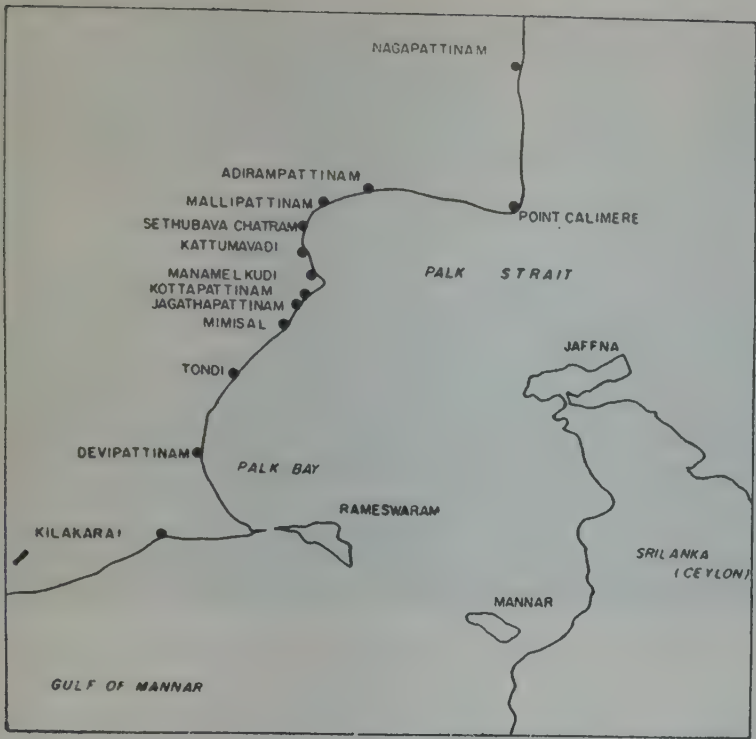


Fig. 1. Map showing the important fish landing centres in Palk Strait.

The mechanised boats in these areas are mainly owned by local fishermen only. Inspite of the local ownership of the mechanised boats, clashes between local mechanised boat operators and indigenous boat operators from the neighbouring areas started in the year 1978 resulting in heavy losses.

Crafts and gears

Apart from mechanised trawlers numbering about 500, there are about 1000 plank built boats and dug out canoes, numbering about 10. As mentioned earlier, only a small number of catamarans, not more than 20, is available in this stretch. The major gears are 'Thallu Valai' (trawl net) 'Sippi Valai', 'Koi Valai', 'Nandu Valai' (all gill nets), 'Adi Valai' (drag net) and 'Thoondi' (hooks & lines).

Catch composition

The annual estimates of marine fish landings in this region from mechanised units were about 50,000 tonnes during 1981 and 1982 forming about 80% of total landings. Out of this, prawn catches accounted for about 3500 tonnes. Major contribution to the prawn came from *Penaeus semisulcatus*, *P. indicus* and *Metapenaeus affinis*. Among others, *Leiognathus*, sciaenids and other crustaceans including the crab *Portunus pelagicus* were the major components.

Reasons for the clashes

Due to the presence of good fishing grounds, particularly for prawns, combined with favourable fishing conditions almost throughout the year in this region, the local fishermen have intensified mechanised fishing. The number of mechanised trawling boats owned by local fishermen at Jagathapattinam, Kottapattinam, Sethubavachatram and Mallipattinam are 120, 180, 80 and 100 respectively. In addition, mechanised trawling boats from other regions such as Colachel, Mandapam, Nagapattinam, Kaveripattinam, Cuddalore and Pondicherry also converge to this area for seasonal exploitation, the major fishing season for prawns being October to March. Increased tempo of mechanised fishing in these centres was not received well by indigenous craft owners of the fishing villages. This culminated in the major clashes between the two sectors in the year 1978, leading to heavy damages.

Regulated fishing

In order to avoid such clashes a Peace Council was formed with the local R.D.O. as Chairman and representatives from State Fisheries Department, mechanised boat owners and indigenous craft owners as members. The Peace Council has drawn up a programme to regulate fishing activities.

Since prawns are caught in good quantities during night time, intensity of fishing at night by both indigenous and mechanised crafts is high, resulting in clashes between these two sectors in the night. It is complained by indigenous craft owners that their gears are damaged by the mechanised crafts during night time and the culprits normally escape in dark. Hence the Peace Council suggested on a quota basis, 3 days night fishing to mechanised crafts in a week, fixing the days in advance and allotted the rest of the four days for non-mechanised crafts. However, during day time between 6.00 hrs and 18.00 hrs there is no such restriction and all crafts are allowed to fish, since during day time there is lesser chances of indigenous gears getting damaged by mechanised crafts. In case indigenous gears get damaged during night by mechanised boats on these four days allotted for indigenous crafts, then due compensation should be given by the mechanised crafts to the affected indigenous craft owners. On the other days since mechanised boats have the right to fish, if the indigenous boats also operate and their gears get damgaed, then no compensation would be paid.

Mechanised boat owners associations and their function

In order to safeguard their interests, mechanised boat owners have formed Associations in each centre and it appears that they strictly adhere to the 3 day

Fig. 2. Boat owners queueing up for receiving tokens at Jagathapattinam.

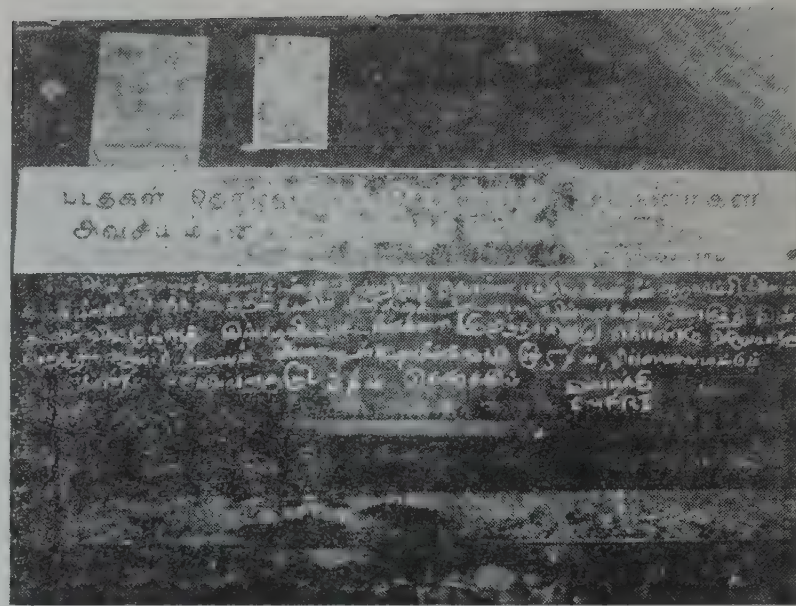


Fig. 3. Display of information to fishermen in front of the Mechanised Boat Owners Association office at Kottapattinam.

Fig. 4. Crabs from the catch for disposal at Kottapattinam.

Fig. 5. Resting mechanised boats and crowed awaiting the catches landed by carrier boats at Kottapattinam.

Fig. 6. Sun drying Silver bellies 'kaaral', part of the catches.

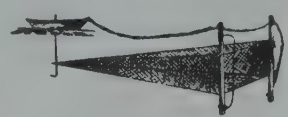
Fig. 7. Calm and quiet.

night fishing in a week. For this purpose they issue tokens on the allotted days of fishing for those mechanised boats after collecting a nominal fee of Rs. 3/– to Rs. 5/– depending on the centre. Apart from this token money, each mechanised boat operator deposits one good sized prawn from the catch to the Association. The sale proceeds adds up to the Association's general fund. The amount thus collected is used for the payment of compensation towards the damages caused to the gears of the indigenous craft owners. This is also utilised for social purposes such as health, education and religious festivals. The unity among mechanised boat owners belonging to different regions, communities and centres, works so nicely that the interest of this sector is well protected.

The orderliness in which the mechanised boat owners come and stand in queue to receive the tokens from 3.00 P.M. onwards on the allotted day for the ensuing night fishing is commendable. The systematic way of collection of token money and prawns and utilisation of the proceeds to various needs of the association members indicates that the programme drawn up by the Peace Council is working satisfactorily.

Conclusion

It is interesting to note that the schedule of restricted night fishing for mechanised boats for 3 days in a week and traditional boats for 4 days is strictly kept up by the respective boat owners without any violation, while all the types of boats operate during day time. It is equally interesting to see that the mechanised boat owners are eager to operate their boats on these three days, strictly adhering to the schedule as evidenced by the way in which they wait for getting the token for night fishing. This implies the economic viability of their operations under these constraints. Therefore, it is suggested that this system of regulated fishing may be extended to other regions where the clashes between these two sectors exist, especially concerning night fishing.



CULTURE OF LARVAE OF *SCYLLA SERRATA**

Introduction

A system has been designed and evaluated for mass rearing of the mud crab *Scylla serrata* (Forskal) in the coastal ponds developed in intertidal mud flats at Tuticorin bay. Declining fisheries of this group throughout most of its range have stimulated a number of aquaculture ventures particularly in few Southeast Asian countries. It is a compatible species and reared profitably with milkfish. Stocking of ponds is dependent on the collection of small crabs from wild for fattening. The success of largescale culture depends upon the various management techniques including the development of hatcheries for the production of seed of this desirable species. A series of experiments were carried out during March-September 1983 and the larvae of the mud crab were successfully reared to crab stage under laboratory conditions for the first time in this Institute. The rearing techniques are simple and relevant for establishment of a hatchery.

Rearing of broods

Ovigerous crabs were obtained from commercial catches and reared in aquarium having suitable facilities with salinity of 32 ± 2‰ and temperature in the range of 26–30°C. Mother crabs were fed with meat of bivalves and shrimp during incubation period. Excess food and at least half the volume of water were removed from rearing tanks every day. The incubation period varied from 8–13 days. At the time of collection, the egg mass appeared completely yellow and compact and the eggs measured 280–380 μ in diameter. As development proceeded with the formation of the chromatophore and the eyes, the egg mass changed the colour to a greyish-yellow, brown, brownish-black and finally complete dark. An increase in the size of egg mass was also evident and the abdomen which was slightly curved became almost straight, continuous with the cephalothorax, and the telson was slightly tilted upwards at the end of incubation (Fig. 1). Later the egg mass became loosened and the abdomen made jerking movements

*Prepared by R. Marichamy and S. Rajapackiam

Fig. 1. Berried female in last phase of incubation.

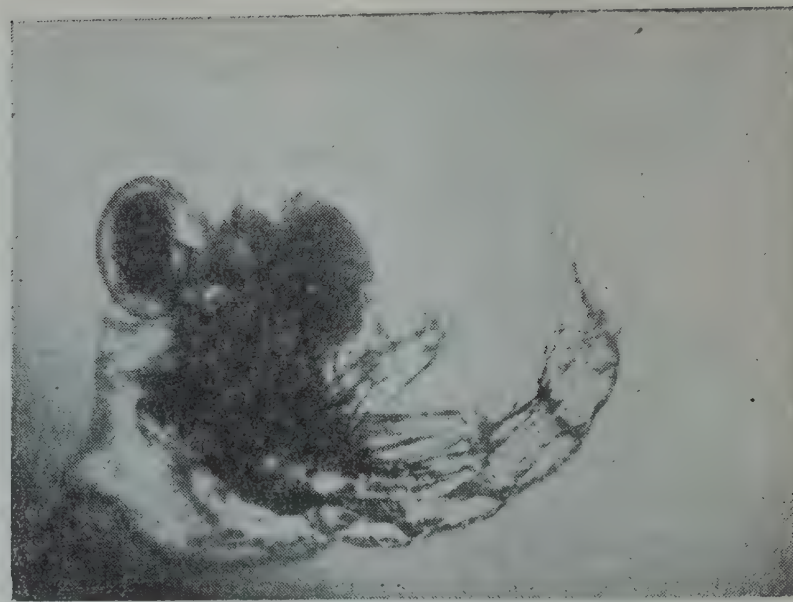


Fig. 2. Newly hatched zoea larva.

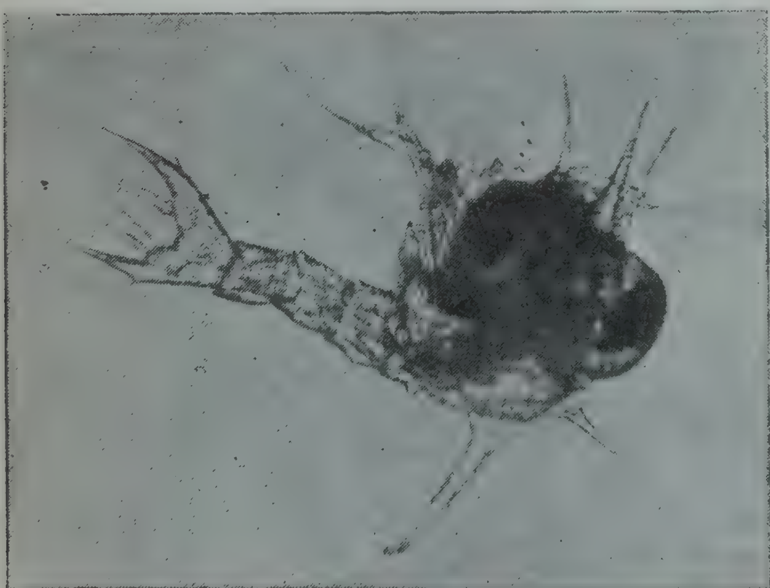


Fig. 3. Zoea V.

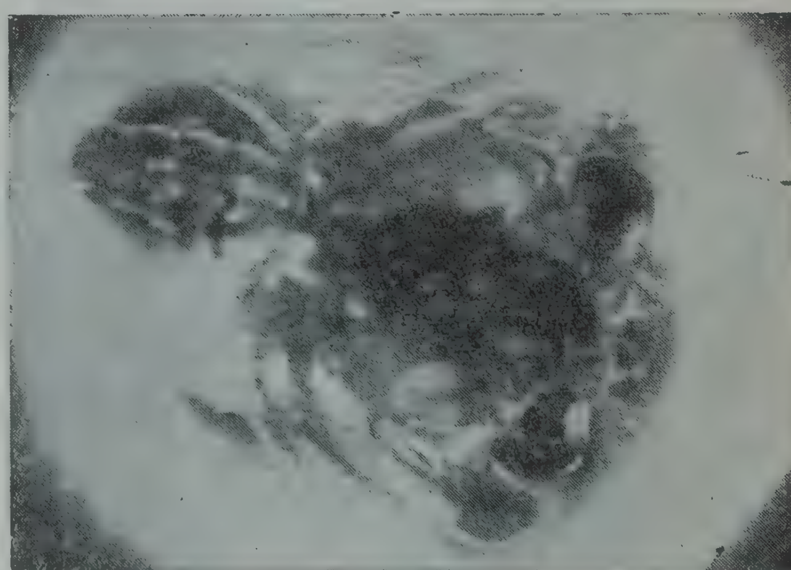


Fig. 4. Megalopa.

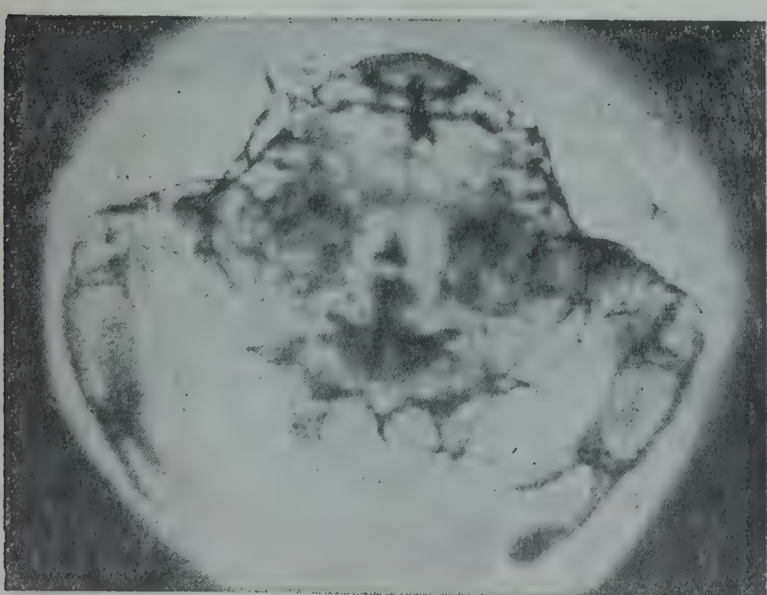


Fig. 5. Moult of first crab instar.

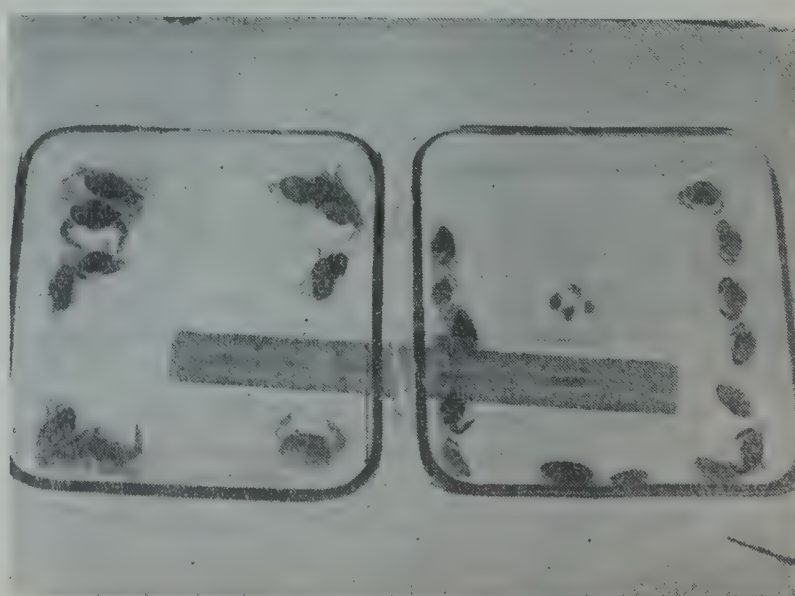


Fig. 6. Young crabs.

in quick succession while the second and fourth walking legs lightly jabbed at the egg mass. The mother crab was restless and by the frequent contraction of the abdomen, the larvae were released from the eggs. Most of the eggs hatched from the berry directly into zoea and a few as prezoea. The larvae were liberated normally around 6 A. M. and the process extended over a period of 2 hours. A maximum of 2 million zoea were hatched out on 18-4-1983 from a crab which measured 140 mm cw.

Larval development

Active newly hatched zoea (Fig. 2) were highly photopositive. These when congregated along water interfaces were transferred into different rearing tanks at a stocking density of 10–50/l. There were five zoea stages and one megalopa in the complete larval development of *S. serrata*. Each zoea took 3–4 days and the megalopa stage was attained on 18–20th day. Further metamorphosis was noticed after an interval of 8–11 days and thus the larval developments continued to 28–30 days to attain first crab instar. Heavy mortality was noticed during first, second and fifth zoea stages. The morphological changes of each stage were observed and recorded. Zoea I measured 1.2 mm while Zoea V measured 3.5 mm (Fig. 3). The cephalothorax of zoea has 4 spines, one dorsal, one rostral and two short lateral spines. All zoea stages except for the first have stalked compound eyes. The abdomen in all stages has lateral knobs on the second and third abdominal segments. Moulting in the zoea and megalopa took place by a split at the dorsal boundary between the cephalothorax and the abdomen. Megalopa resembled like a crab and swam by means of five pairs of pleopods which were functional for the first time. Prominent chelipeds were developed to catch prey (Fig. 4). Cannibalistic tendency was clearly indicated from this satge onwards. Carapace length including rostral spine measured 2.5 mm. A heavy mortality was noticed again when they turned into crab stage. The carapace length of first crab measured 3.2 mm while the width was 3.7 mm with slight variation. The length of the first crab instar in relation to the width was longer than in all later stages. Nine antero-lateral spines in carapace were formed and the abdomen was curved beneath the cephalothorax as in adult stage. The carapace, eye stalks and the periopods were marked with chromatophores which were able to change colour. The first crab instar moulted to second crab in 5 days period (Fig. 5) and the moutling of second to the third instar took 4 days. A constant greenish-grey colour of carapace was noticed after the 7th moult. First instar crab although capable of sustained swimming, adopted an almost exclusive benthic habit.

Water quality and feeding

The preliminary study concerns the effects of water quality, antibiotics, phytoplankton and food on larval survival and development. It revealed several potential areas for more detailed research in larval biology. Several sea water treatments were conducted to determine their effect on larval survival and development. Filtered sea water was used directly or sterilized by passing water through a unit containing ultraviolet germicidal lamps. A commercial preparation of penicillin and streptomycin in powder form were used to minimize bacterial infection of crab larvae. Zoea and megalopa stages were maintained at salinity of $32 \pm 2‰$ at temperature varying from 25 to 30.5°C. Water was changed daily. The excess food settled at the bottom, as well as the moulted shell and dead larvae were siphoned out. Continuous aeration was provided in all tanks. Once in four days, samples were taken from the rearing tank and zoea were counted to provide estimates of the number of surviving larvae. The larvae were fed with different types of food. *Chlorella* sp. was added during first three days. Second and third zoea were supplied with rotifers as well as frozen *Artemia* nauplii. The later stages were fed exclusively with newly hatched nauplii of *Artemia salina*. Attempts were made to rear megalopa in diluted sea water and with food consisting of live copepods and macerated prawn meat. Loss of larval stock was controlled when megalopa were reared in samll compartments or at lower stocking density with intensive feeding. After reaching crab stage (Fig. 6) the mortality was negligible at lower stocking density.

Remarks

Experiments conducted so far, in rearing the larvae were unfortunately of little commercial value and labour intensive. It calls for further investigation if laboratory production of the early crab stages as seed stock for culture in ponds is to be achieved. Efforts are in progress to culture the larvae of this valuable species. The present findings envisage the scope to develop the hatchery for the large scale production of crab seeds. An improved system is designed for a direct scale-up potential at Tuticorin Research Centre of Central Marine Fisheries Research Institute.

TWO INCIDENTS OF FIRE ACCIDENT AT MADRAS FISHING HARBOUR DURING THE MONTH OF APRIL '84*

On the early hours of 5–4–84 at about 4 A.M. the first fire accident took place. On the southern side of the fish landing centre at Kasimode, one of the thatched sheds, used mainly for prawn peeling and handling caught fire first. The fire quickly spread in the northern direction causing complete damage to 42 sheds, six trawlers, 22 sets of *catamarans*, one fibre glass boat and six trawl nets. At the adjoining site the fire devastated all the equipments and tools used in the dry docking of mechanised boats. Sheds belonging to the Madras Fishermen Co-operative Federation and Tamil Nadu Fisheries Corporation were also affected by the fire. Ten fire fighting units battled for more than four hours and brought the fire under control. The estimated loss was over six lakhs. Fortunately there was no loss of life. The breakup figures for the material loss is as follows:

Cost of trawlers: Rs. 5,20,000.00

Cost of carrier boat (fibre glass): Rs. 35,000.00

Cost of catamarans: Rs. 20,000.00

Cost of equipment used in dry docking the boats: Rs. 20,000.00

Cost of fishing nets: Rs. 21,000.00

Total loss: Rs. 6,16,000.00

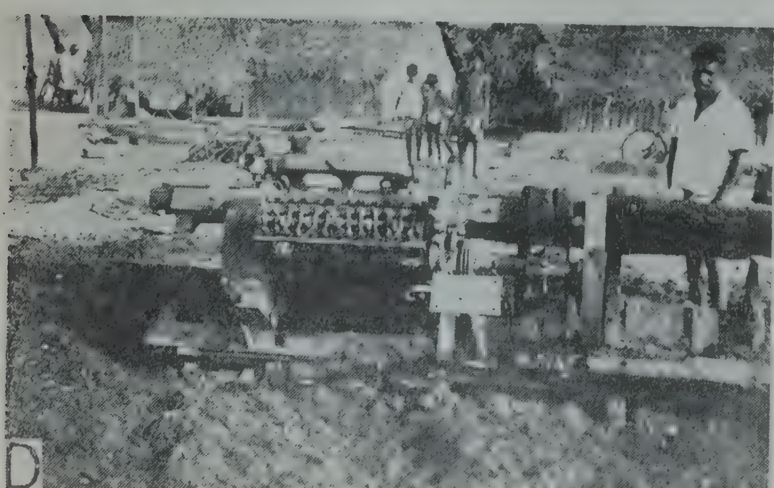
Within a fortnight, another instance of fire outbreak took place on 16–4–84 in the vicinity of the first fire disaster. The second fire accident according to press reports and personal enquiry, took place in the early morning. The fire broke out on the northern side, well beyond the existing compound wall away from the shore. A total number of 204 sheds including five tea stalls were destroyed in the fire accident. Again there was no loss to life. No fishing boats were affected. Only 15 nets were damaged by the fire. The total loss was estimated to be around seven lakhs.

A

Two old boats kept for repair burnt out.

C

Partly burnt fibreglass boat.



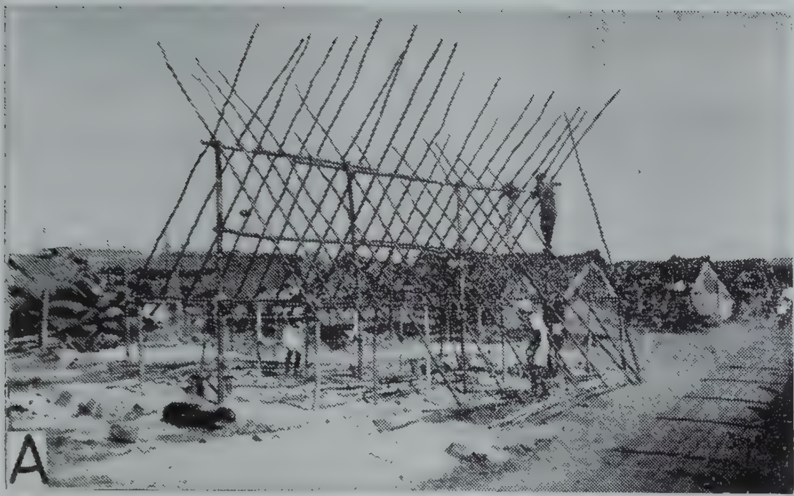
D

Engine of a boat destroyed by fire.

F

Location of prawn peeling shed - totally gutted.

* Prepared by D. B. James, R. Sarvesan and S. Chandrasekar.



Burnt shed being reconstructed.

Area showing burnt sheds.

Burnt planks of *catamaran*.

Area showing place where prawn peeling sheds were completely gutted.

Planks of *catamaran* damaged by fire.

Burnt peeling sheds showing the partly burntout poles.

Compiled and prepared by Dr. M. J. George, Dr. K. J. Mathew, Mr. G. Nandakumar & Miss Jancy Jacob
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No. 59
SEPTEMBER, OCTOBER
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THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the National Marine Living Resources Data Centre (NMLRDC) and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

Abbreviation - *Mar. Fish. Infor. Ser. T & E Ser.*, No. 59: 1984

CONTENTS

Cover photo: Heaps of lime collected by fishermen and kilns in which the shells are processed for commercial purposes at Kakinada

THE MOLLUSCAN RESOURCES AND ECOLOGY OF KAKINADA BAY

K. A. Narasimham, G. S. D. Selvaraj and S. Lalitha Devi

Kakinada Research Centre of C. M. F. R. I., Kakinada–533 002

Introduction

In the Kakinada Bay several species of bivalves and gastropods are regularly fished and the annual production has been estimated to be about 6,000 t (Narasimham, 1973). Among them the windowpane oyster *Placenta placenta* (Linnaeus) and the blood-clam *Anadara granosa* (Linnaeus) are of particular interest. In India the latter forms a fishery only in Kakinada Bay while the former is fished also in Pindara Bay in the Gulf of Kutch and in Goa. The molluscs are mainly used as lime shell and the flesh is eaten locally to a limited extent. In general, the production during the last two decades has been static mainly due to low demand. However, in 1983 trial consignments of the frozen meat of the windowpane oyster and the blood-clam collected from the bay were exported to Japan by an entrepreneur and were received well. As the export market is being developed one would expect the picture to change rapidly. In the light of these developments it was felt that a quick survey of the bay to estimate the abundance of the constituent species would be useful to the industry. Further, such basic information is necessary to evolve, suitable managment policies. With these objectives a survey of the Kakinada Bay was conducted in March-April 1983. Also the results of a survey conducted in the last week of March 1979 of the Kakinada (Upputeru) canal have been incorporated in this report. Environmental data which may have bearing on the distribution and abundance of the molluscs were also collected.

Earlier works in the bay relevant to this study were mainly related to hydrography (Ramasarma and Ganapati, 1968), sediments and their organic carbon (Rao, 1967), bottom fauna (Radhakrishna and Ganapati, 1968) and molluscan resources (Narasimham, 1973 and Murthy *et al.*, 1979).

Physiography of the Bay

The bay lies between 16° 51′ N to 16° 59′ N and 82° 15′ E to 82° 22′ E and covers an area of 146 km². It opens into the Bay of Bengal in the north by a 5.6 km wide mouth, bordered on the west by mainland, on the south by extensive mangrove forests and on the east by a narrow sand bar called Hope Island (Fig. 1). It has a maximum length of 14.8 km and width of 13.0 km. The Kakinada (Upputeru) canal, Chollangi canal, Matlapalem canal, Coringa river, Gaderu river and Pillavarava creek, which

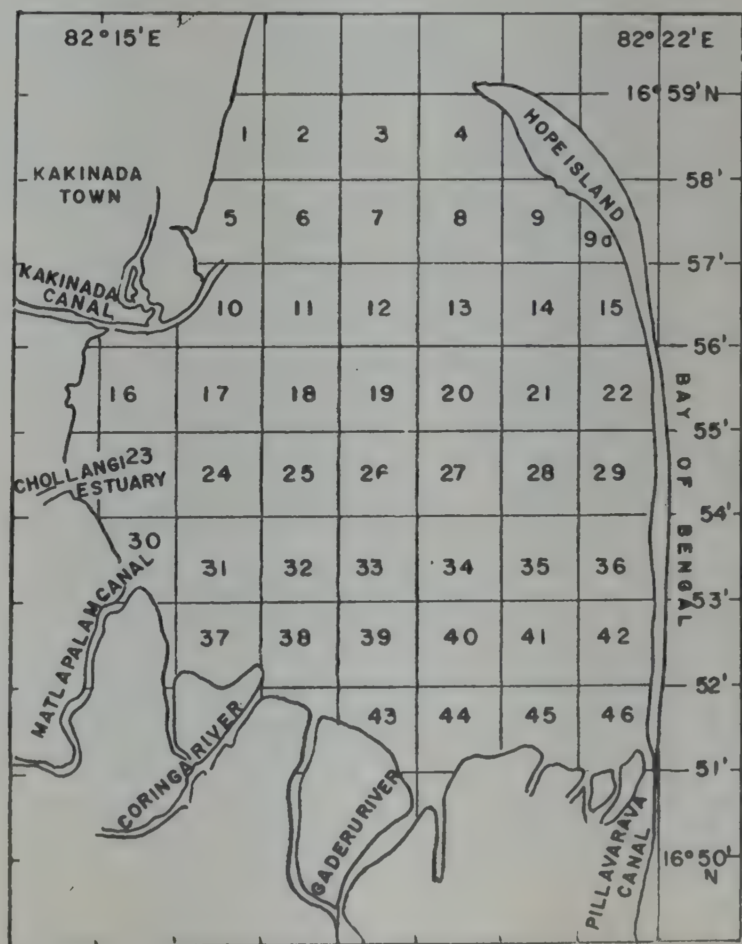


Fig. 1. Map of Kakinada Bay showing the squares.

are connected to the Gautami branch of the Godavari river, open into the Bay. It is shallow and large mud flats are exposed at low tide on the southern and western sides. The maximum depth is 6.8 m and only in the northern section, it is > 3 m. The tides are semi-diurnal and the maximum amplitude during spring tides is 1.8 m.

Survey methods

Following Murthy *et al.* (1979), the Bay was divided into 47 squares, each measuring 1 sq. nautical mile or 3.43 km^2 excepting those bordering the land which are smaller (Fig, 1 and Table 1). A 4 m fibreglass dinghy fitted with 7.5 h.p. outboard motor was used in the survey conducted from 22-3-1983 to 28-4-1983. In each square the following equipments were used/ samples collected manually.

Table 1. *Square-wise extent and depth (at low tide) of the Kakinada Bay and the dates of the survey*

Square No.	Area (m^2)	depth (m)	Date of survey
1.	15,94,950	0.8	7–4–83
2.	34,29,904	2.4	27–4–83
3.	34,29,904	5.2	27–4–83
4.	33,18,525	6.8	27–4–83
5.	25,38,200	1.0	5–4–83
6.	34,29,904	2.2	6–4–83
7.	34,29,904	3.1	27–4–83
8.	34,29,904	4.6	23–4–83
9.	27,44,000	3.0	23–4–83
9a.	8,23,200	2.0	22–4–83
10.	20,83,725	0.4	22–3–83
11.	34,29,904	2.4	2–4–83
12.	34,29,904	2.6	4–4–83
13.	34,29,904	2.8	22–4–83
14.	34,29,904	2.0	22–4–83
15.	21,43,750	1.8	23–4–83
16.	34,29,904	0.0	25–4–83
17.	34,29,904	1.2	25–4–83
18.	34,29,904	1.5	25–3–83
19.	34,29,904	1.8	13–4–83
20.	34,29,904	1.8	13–4–83
21.	34,29,904	0.9	21–4–83
22.	28,72,625	0.9	23–4–83
23.	34,29,904	0.0	26–4–83
24.	34,29,904	0.3	26–4–83
25.	34,29,904	0.9	26–4–83
26.	34,29,904	1.0	11–4–83
27.	34,29,904	1.5	11–4–83
28.	34,29,904	0.9	11–4–83
29.	28,89,775	0.3	10–4–83
30.	25,21,050	0.0	26–4–83
31.	34,29,904	0.6	28–4–83
32.	34,29,904	0.6	21–4–83
33.	34,29,904	0.3	21–4–83
34.	34,29,904	0.6	21–4–83
35.	34,29,904	0.3	21–4–83
36.	28,12,600	0.6	12–4–83
37.	28,89,775	0.0	28–4–83
38.	34,29,904	0.6	20–4–83
39.	34,29,904	0.0	20–4–83
40.	34,29,904	0.1	20–4–83
41.	34,29,904	0.3	20–4–83
42.	29,58,375	0.1	12–4–83
43.	21,86,625	0.6	19–4–83
44.	32,07,050	0.3	19–4–83
45.	29,24,075	0 0	19–4–83
46.	26,32,525	0.1	12–4–83
Total	14,60,37,945		

1. A dredge of 0.5 m opening and with 15 mm synthetic yarn mesh (Pl. 1) was hauled 4–6 times, each haul covering 5m^2 area.

2. A clam seed sampler of 0.5 m opening and with 4 mm synthetic yarn mesh (Pl. 2) was hauled twice, each haul covering 1m^2. The samples obtained by these gears were sieved through 1 mm mesh, species identified, counted, weighed and specimens in the sub-sample measured for length in the anteroposterior direction.

3. Van Veen grab covering 10 cm x 10 cm was operated once and the material was sieved through 0.5 mm mesh.

4. Sediment collected by the grab was analysed for particle size by using test sieves. Wentworth's grade scale (Welch, 1948) was followed.

5. Organic carbon of the sediment collected by the grab was analysed by the chromic acid titration method (F.A.O. 1975).

6. 10-minute plankton hauls with plankton net of 50 cm ring diameter and 0.3 mm mesh size were made. Subsamples were made using Folsom plankton splitter (Wickstead, 1976), and studied. The organisms were counted and estimates were made for whole sample.

7. Surface water samples were collected and analysed for temperature, salinity (Mohr's titration method), dissolved oxygen (Winkler's method), inorganic phosphate, silicate, nitrite and nitrate (Calorimetric method using spectrophotometer). Wherever desired transparency was studied. The samples were collected during 0600 to 1200 hrs. The Kakinada canal concrete embankments were surveyed by fixing stations 200 m apart and collecting samples from 1 m^2 area at each station.

Hydrography

Transparency: The water was highly turbid with secchi–disc reading not exceeding 50 cm except on the northeastern side where it was clear with secchi-disc values upto 150 cm.

Temperature: Water temperature varied from 25.6° to 32.5°C with maximum in square 22 and minimum in squares 20 and 21 (Fig. 2).

Salinity: Salinity values ranged from 28.9‰ to 35.0‰ (Fig. 3) with maximum in square 20 and minimum at Kakinada canal confluence (square 5) and Coringa confluence (square 38).

Dissolved oxygen: The range in the dissolved oxygen values observed was from 2.0 ml/l in squares 20 and 21 to 7.0 ml/l in squares 14, 23 and 41 (Fig. 4). The distribution of the low values of dissolved oxygen indicated the formation of an eye in the circulation pattern around squares 20 and 21 which is associated with low temperature and high salinity profile.

Inorganic phosphates: Phosphate values ranged between 1.00 and 3.00 μ g at/l (Fig. 5). The tidal flats on the western side had maximum phosphate content (2.7–3.0 μ g at/l) which may be due to land drain by the Kakinada, Chollangi and Matlapalem canals. Similarly the Pillavarava confluence on the southeastern side was relatively rich in phosphates (1.82–2.2 μ g at/l). While the Gaderu and the Coringa confluences had moderate phosphate content (1.2–1.85 μ g at/l) lowest values were obtained on the northeastern side of the bay in squares 8, 9 and 20.

Silicate: The values varied from 11.0 to 67.0 μ g at/l with maximum around Coringa confluence (squares 32 and 38) and minimum in square 8 (Fig. 6). The distribution showed low values (11–22 μ g at/l) on the northern side of the bay. However, a patch of high silicate values was recorded in squares 15 and 22, close to the bay opening into the sea.

Nitrite: The range in the nitrite values fluctuated between 0.36 and 1.45 μ g at/l with maximum in square 21 and minimum in square 8 (Fig. 7), where the silicate was also low. Similarly Coringa confluence had high nitrite content (1.21–1.33 μ g at/l) as is the case with silicate.

Nitrate: The values ranged from 1.1 to 4.0 μ g at/l with maxima in squares 1, 2, 4, 21, 22 and 23 (Fig. 8) and minimum at Pillavarava confluence. In general in the southern and western parts the nitrate was present in moderate concentrations.

Zooplankton: The foraminifera was represented by *Globigerina* sp. *Obilia* spp., *Liriope tetraphylla, Eutima mira, Aequorea* spp., *Aurelia* spp., *Bougainvillia* spp. and *Phialidium* spp. were the representative hydromedusae. On an average they formed 0.5% in zooplankton and were abundant in squares 41, 46 and 29. Siphonophores formed about 0.3% and were represented by *Lensia* spp., *Muggiaea* spp, *Dimophyes* spp. and *Eudoxides* spp. Ctenophores formed on an average 0.3% and were represented by *Beroe* spp. and *Pleurobrachia* spp. The chaetognaths contributed about 0.6% and the common species were *Sagitta inflata* and *S. robusta.* Cladocera and ostracoda accounted for 0.3% and were commonly represented by *Evadne* sp. and *Cypridina* spp.

At different stations the copepods contributed from 0.2 to 91.0% in total zooplankton (average 11.6%). Calanoid genera were common and were represented by *Calanus, Rhincalanus, Eucalanus, Calocalanus, Paracalanus, Pseudocalanus, Microcalanus Eucaheta, Temora, Centropages, Labidocera, Parapontella* and *Acartia.* Other genera in the samples were *Oithona, Corycaeus, Euterpina* and *Microstella.* Parasitic forms *Lernaea* spp. and *Caligus* spp. were encountered in squares 4, 10, 13, 19, 24–26, 32, 33, 43 and 44.

The amphipods formed less than 0.2%; *Hyperia* spp. and *Corphium* spp. being the common. The appendicularians constituted less than 0.2%. Adult decapods were represented by *Acetes indicus* and *Lucifer* spp. and they contributed from 0.02 to 84.4% in different squares with an average of 13.6%.

The decapod larvae contributed from 0.03 to 65.6% in different squares with an average of 10.5% of which the crab larvae belonging to Porcellanidae, Paguridae, Pinnotheridae, *Portunus* spp. and *Carcinus* spp. formed 9.4%. Others were phyllosoma larva, alima larva and various larval stages of penaeid prawns namely *Penaeus indicus, Metapenaeus brevicornis, M. affinis, M. dobsoni* and *M. monoceros.*

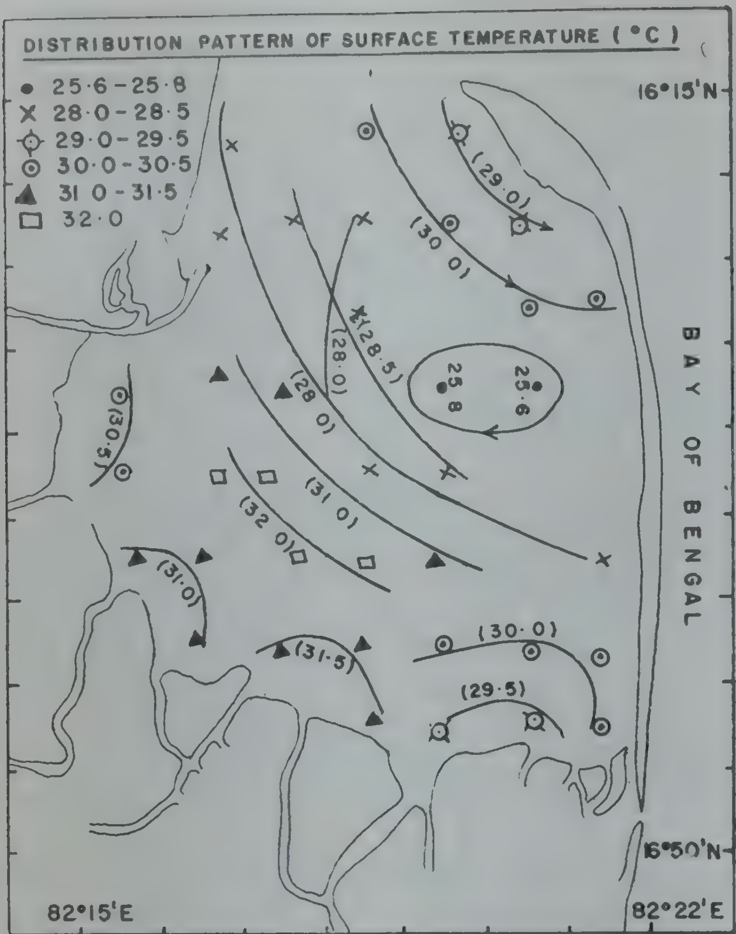


Fig. 2. Surface temperature (°C) of the water in the bay.

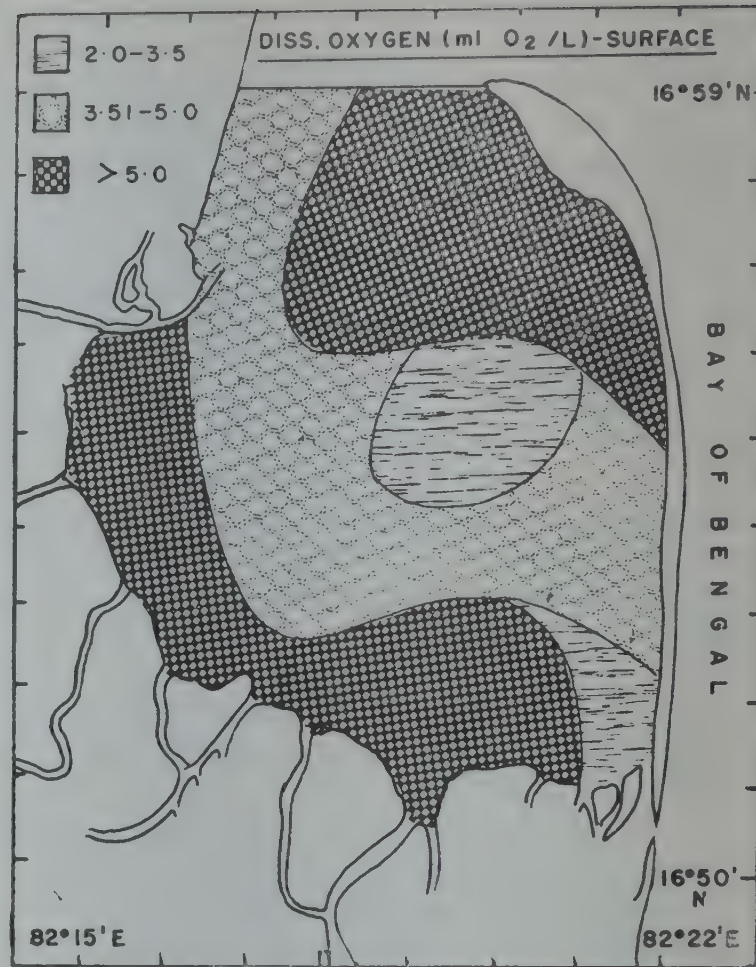


Fig. 4. Distribution pattern of dissolved oxygen (ml/l) in the bay.

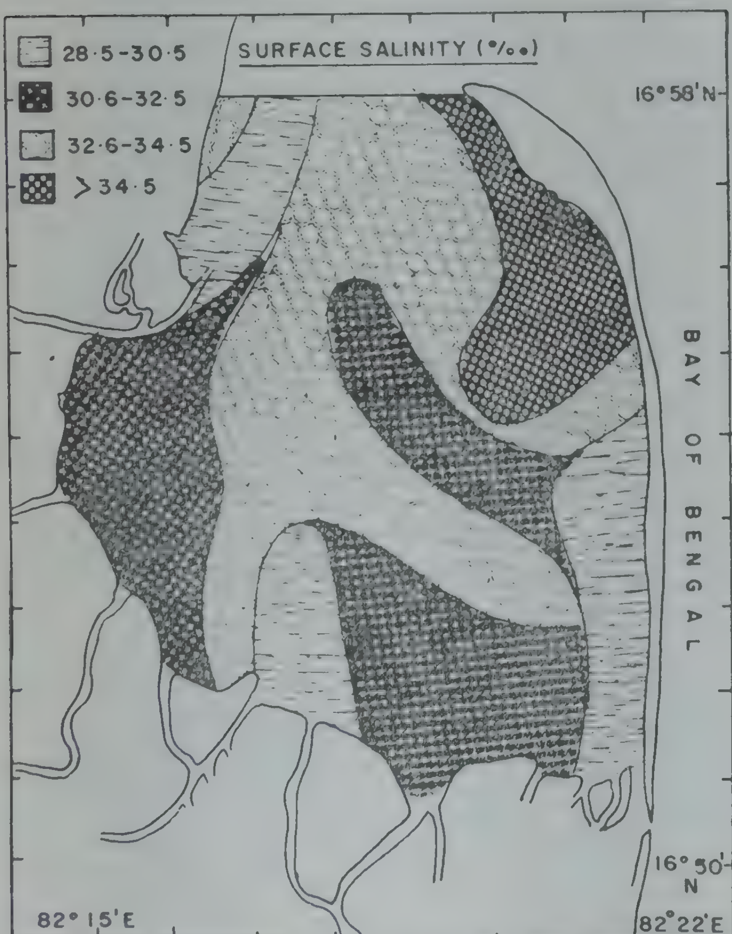


Fig. 3. Distribution pattern of salinity (‰) in the bay.

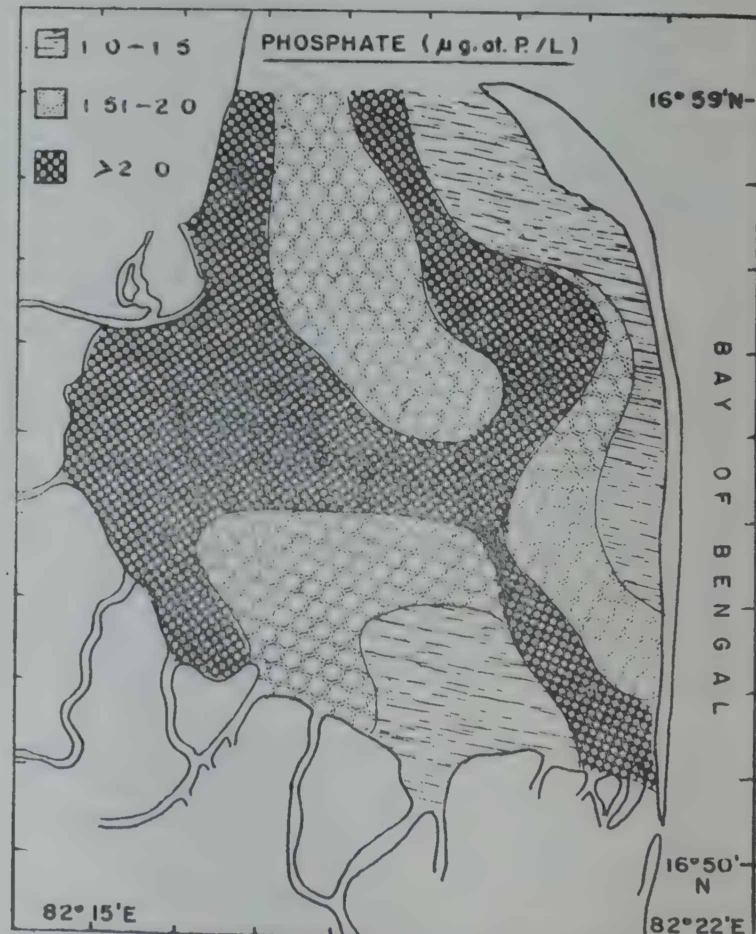


Fig. 5. Distribution of inorganic phosphates (µg at/l) in the bay.

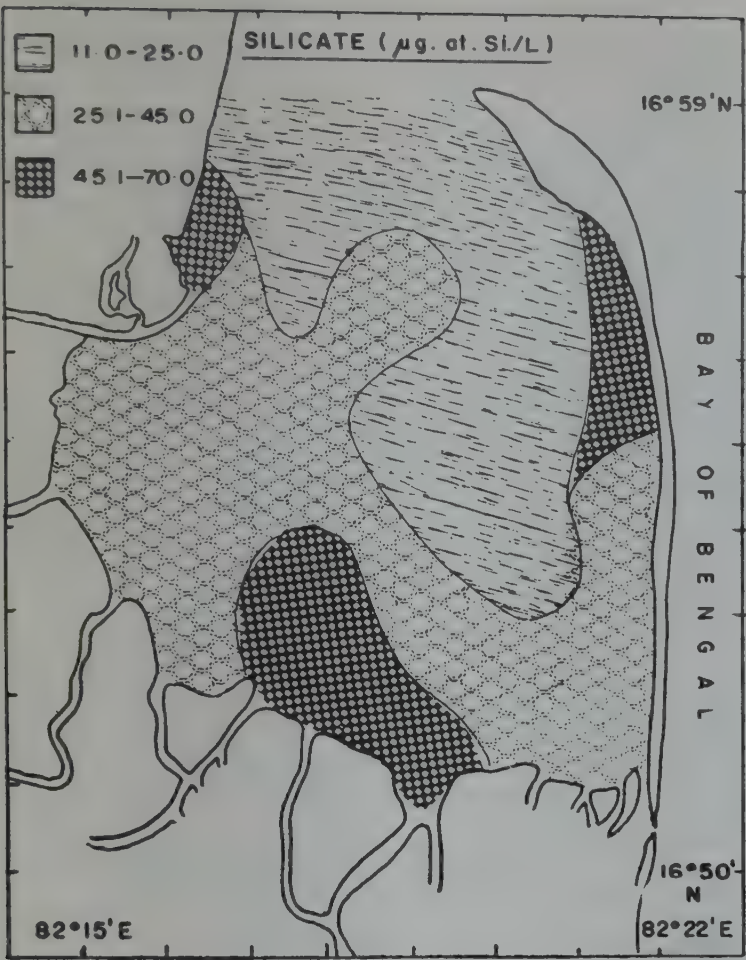


Fig. 6. Distribution of silicate (μg at/l) in the bay.

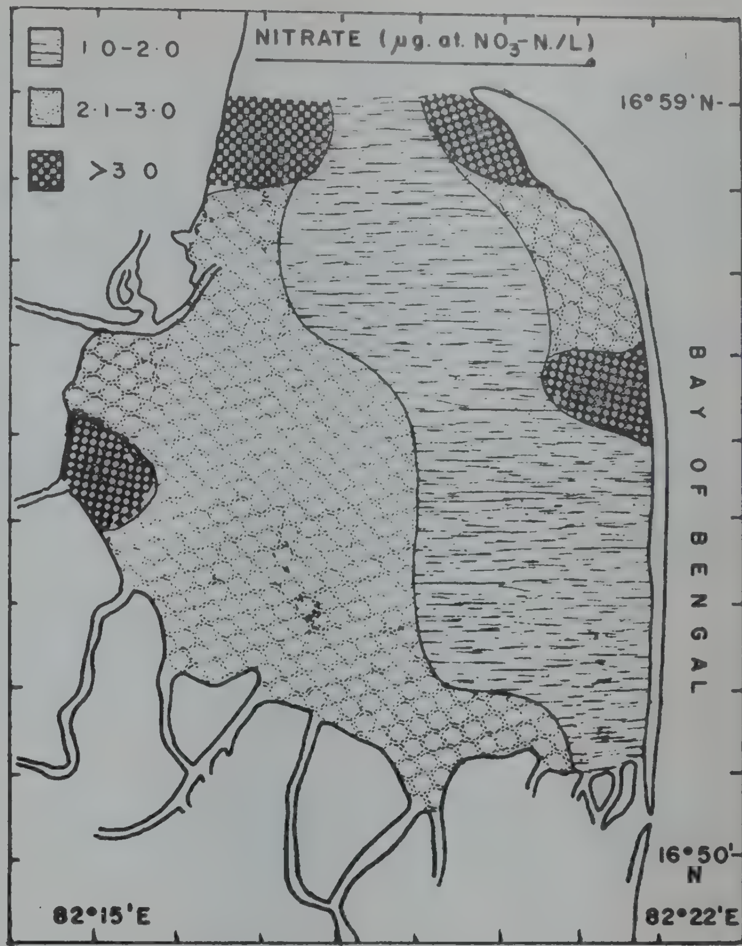


Fig. 8. Distribution of nitrate (μg at/l) in the bay.

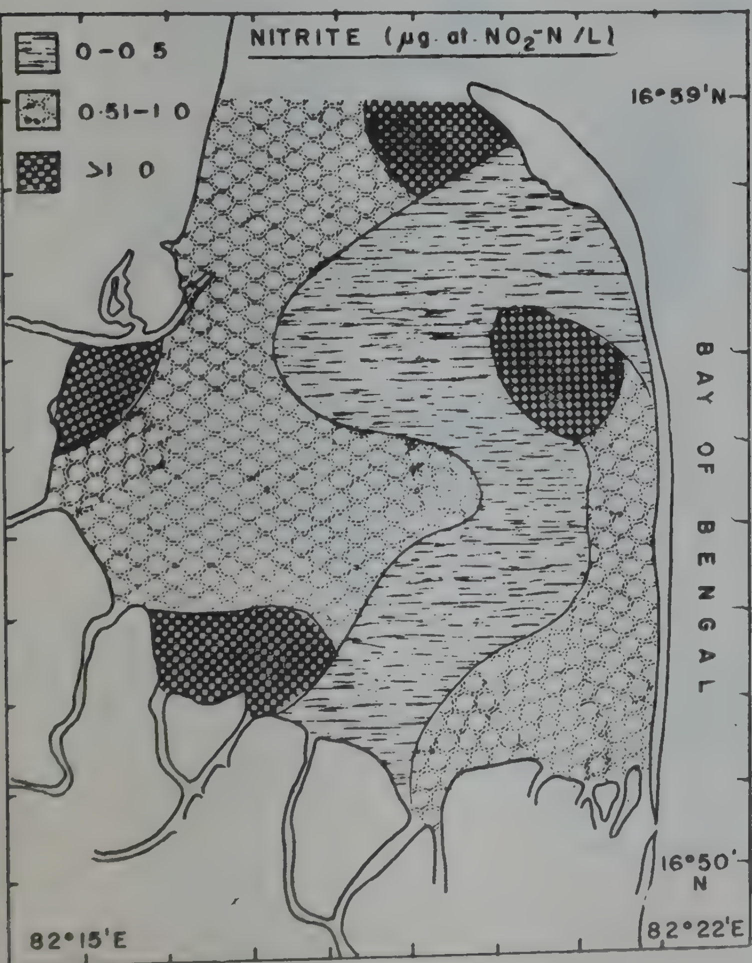


Fig. 7. Distribution of nitrite (μg at/l) in the bay.

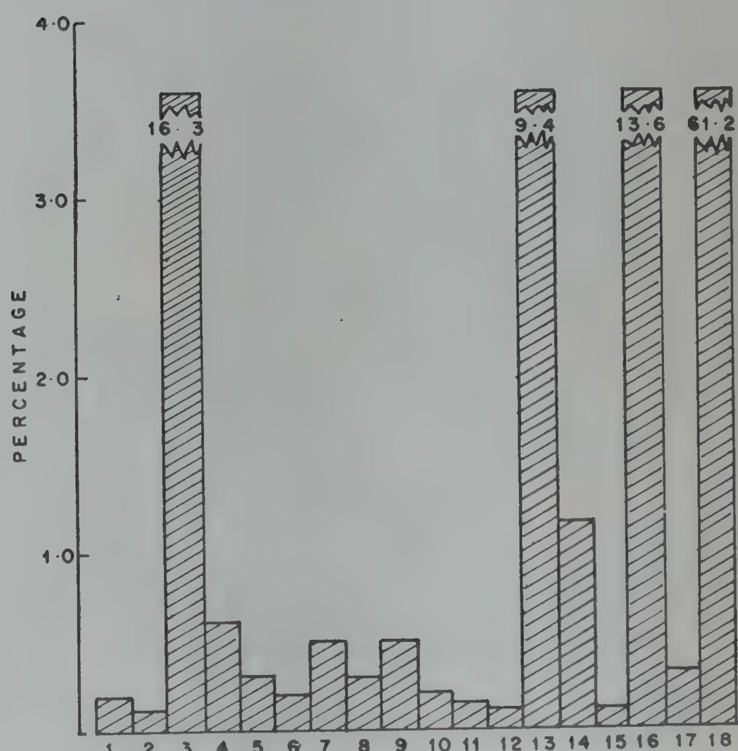


Fig. 9. Average zooplankton biomass in the bay. 1. Alima larvae 2. Amphipods 3. Copepods 4. Chaetognaths 5. Ctenophores 6. Cladocerans 7. Medusae 8. Mysids 9. Molluscan larvae 10. Oikopleura 11. Parasitic copepods and Isopods 12. Phyllosoma larvae 13. Crab larvae 14. Prawn larvae 15. Polychaete larvae 16. *Lucifer* 17. Siphonophores and 18. Fish eggs and larvae.

Polychaete larvae nepthyid and phyllodocid were encountered and the polychaete larvae contributed on an average of 0.03%. Bivalve veligers, young gastropods and pteropds formed about 0.6% in zooplankton. Bivalve larvae were common in squares 3–5, 7, 10, 13, 18–20 30, 33–36, 38, 40–44 and 46. The percentage composition of fish eggs and larvae varied from nil to 99.6 with an average of 61.2% in zooplankton (Fig. 9). The common forms were the eggs and larvae of clupeidae, Mullidae, Gobidae, Pleuronectidae and Belonidae.

As the survey was conducted in the summer months the hydrographical conditions as well as the composition of plankton in the bay were typically marine. Generally the plankton was rich in the variety of species. While the collections made between 6 and 8 hrs. were dominated by fish eggs and larvae, pelagic tunicates, crustacean larvae, *Lucifer* sp. and copepods, those made around noon comprised mostly of coelenterates and chaetognaths.

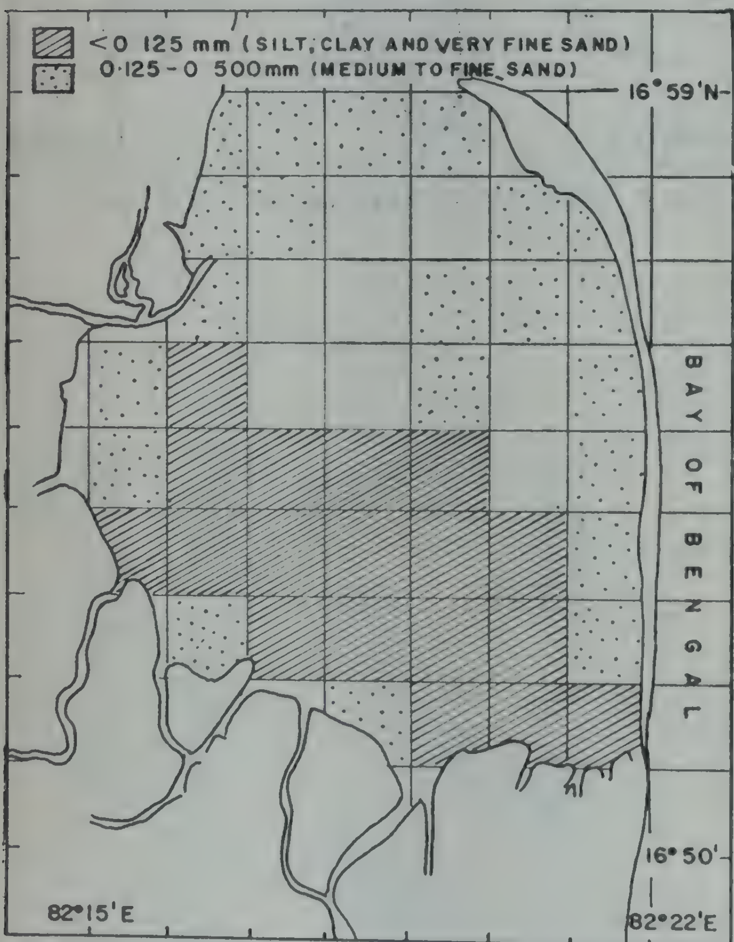


Fig. 10. Particle size of the sediments in the bay. Each category indicates the predominant type (over 50%)

Sediments

Particle size: The results of the particle size analysis by weight are shown in Table 2. In the southern and southwestern part of the bay the sediment is predominantly composed of clay, silt, and very fine sand (particle size < 0.125 mm) (Fig. 10). The rivers and irrigation canals bring in considerable quantities of these fine particles resulting in soft bottom in these areas. On the other hand, the sediments of the eastern and northern parts of the bay are predominantly made up by fine to medium sand (particle size between 0.125 to 0.500 mm) due to the influence of the strong tidal currents from the sea. The Hope island Itself is a sand bar.

Organic carbon: Organic carbon content in the sediments (Fig. 11) was highest along the southwestern tidal flats (0.9–11%) and lowest along the northeastern side close to the sand bar. Another diagonal belt of high values ranging from 0.87 to 1.02% was recorded in the central portion of the Bay in southeast to northwest direction. Coringa and Gaderu confluences had lower values (0.3–0.6%) while the northern side close to the mouth of the bay had median values (0.6 - 0.8%). The present study indicates that regions of fine sediments are generally rich in organic carbon.

Fig. 11. Organic carbon (1%) in the sediments of the bay.

Molluscan resources

Based on the dredge collections the square-wise estimates of live molluscs and holothurians by weight and numbers are given in Table 3.

Table 2. *Particle size and organic carbon in the sediments*

Square No.	Particle size of sediments in % (by weight)							Organic carbon (%)
	>2000 Microns	1000–2000	500–1000	250–500	125–250	63–125	<63	
1.	—	—	13.7	22.8	28.0	34.8	0.7	0.74
2.	—	—	14.4	20.2	39.6	21.6	4.2	0.62
3.	—	—	10.3	9.2	48.7	28.3	3.5	0.60
4.	—	—	5.6	19.3	45.9	26.9	2.3	0.65
5.	—	—	—	47.2	49.3	3.1	0.4	0.71
6.	—	—	—	17.8	56.5	25.1	0.6	0.96
7.	3.0	—	13.8	19.1	22.2	40.7	1.2	0.77
8.	—	—	2.8	3.9	45.8	41.9	5.6	0.21
9.	0.2	—	1.8	3.2	50.4	42.8	1.6	0.21
9A	3.0	0.1	—	2.5	62.8	31.2	0.4	0.13
10.	0.6	—	—	11.5	41.4	43.7	2.8	0.71
11.	—	—	25.2	21.3	15.7	37.1	0.7	0.87
12.	8.5	—	30.1	20.1	21.8	9.9	9.6	0.97
13.	0.9	0.1	—	25.6	36.5	33.2	3.7	0.90
14.	1.0	—	—	18.2	44.8	34.2	1.8	0.66
15.	0.2	—	2.1	4.1	48.1	37.5	8.0	0.62
16.	0.2	—	7.7	12.7	52.9	23.7	2.8	0.99
17.	2.6	—	2.5	4.2	24.1	64.6	2.0	0.65
18.	0.5	—	18.6	17.6	20.0	23.4	19.9	0.50
19.	—	—	17.8	23.6	22.6	24.2	11.8	0.74
20.	0.5	0.1	—	—	57.3	40.6	1.5	0.71
21.	0.8	—	22.4	19.9	24.1	22.7	10.1	1.02
22.	—	—	—	7.3	80.0	12.7	—	0.06
23.	1.1	—	—	37.1	27.3	21.8	12.7	1.10
24.	—	—	—	10.5	28.5	59.4	1.6	0.71
25.	—	—	—	16.8	25.5	51.8	5.9	0.91
26.	0.8	—	2.5	5.0	33.0	56.2	2.5	0.40
27.	1.0	—	4.0	5.5	32.9	46.9	9.7	0.37
28.	—	—	9.0	10.9	35.9	42.4	1.8	0.87
29.	0.9	—	16.7	21.0	31.7	28.5	1.2	0.13
30.	—	—	4.4	0.6	7.0	69.4	18.6	0.87
31.	0.2	—	7.2	7.2	17.5	53.3	14.6	0.87
32.	0.8	—	—	32.4	12.6	47.5	6.7	0.71
33.	0.7	—	13.2	15.4	20.2	48.1	2.4	0.77
34.	—	—	4.6	7.6	21.1	63.7	3.0	0.71
35.	1.2	—	3.9	7.6	34.0	49.5	3.8	0.59
36.	—	—	—	18.8	35.8	40.3	5.1	0.75
37.	—	—	—	18.7	42.8	38.1	0.4	0.99
38.	—	—	—	9.9	30.9	57.2	2.0	0.59
39.	—	—	10.0	9.8	27.7	48.1	4.4	0.59
40.	—	—	—	7.2	22.8	57.8	12.2	0.47
41.	—	—	2.9	6.9	28.8	56.0	5.4	0.44
42.	1.4	—	—	25.9	29.9	41.8	1.0	0.90
43.	0.4	—	—	8.8	44.9	44.3	1.6	0.34
44.	—	—	3.5	5.2	8.7	75.8	6.8	0.31
45.	—	—	—	12.1	24.6	54.6	8.7	0.56
46.	1.6	—	6.4	3.7	20.9	51.8	15.6	0.50

Table 3. *Molluscan and holothurian resources of the Kakinada Bay* (t: *in tonnes* & Nos.: *in lakhs*)

Square No.	*Placenta placenta*		*Anadara granosa*		*Paphia textille*		*Tellina* sp		*Pinctada chemnitzi*		*Meretrix meretrix*		*Hemifusus pugilinus*		*Cerithidea fluviatilis*		*Acaudina molpadioides*	Others
	t	Nos.	t	Nos.	t	Nos.	t	Nos.	t	Nos.	t	Nos.	t	Nos.	t	Nos.	Nos.	t
1.	—	—	22.3	7.97	2.6	10.10	—	—	—	—	—	—	—	—	—	—	—	—
2.	21.2	8.00	35.7	20.6	18.4	21.72	3.0	16.07	—	—	—	—	—	—	5.9	4.6	4.57	2.1
3.			—	—	20.6	80.95	4.4	19.21	—	—	—	—	—	—	—	362.2	160.52	15.0
4.	—	—	—	—	—	—	—	—	—	—	—	—	56.4	8.29	—	—	—	—
5.	—	—	129.5	47.38	12.4	42.30	—	—	—	—	—	—	14.3	5.92	—	—	—	11.3
6.	—	—	—	—	23.0	117.76	—	—	—	—	—	—	—	—	—	—	—	4.0
7.	—	—	137.5	53.51	17.8	89.18	2.7	24.70	—	—	—	—	20.6	2.74	—	42.5	39.79	—
8.	—	—	—	—	—	—	3.8	44.59	—	—	—	—	8.6	1.71	—	25.7	10.30	—
9.	—	—	—	—	—	—	—	—	105.4	27.44	—	—	5.5	2.20	—	—	—	—
9a.	—	—	—	—	5.1	19.76	—	—	—	—	—	—	—	—	—	—	—	—
10.	300.1	83.35	118.4	42.51	—	—	—	—	—	—	—	—	4.2	1.67	—	—	—	1.7
11.	452.9	139.94	186.6	82.32	1.4	9.60	—	—	—	—	—	—	6.9	2.74	—	—	—	5.5
12.	111.7	28.58	20.0	10.29	144.7	176.07	—	—	—	—	—	—	22.0	2.29	—	—	—	5.8
13.	—	—	—	—	49.7	178.35	—	—	—	—	—	—	17.2	3.43	—	—	—	—
14.	—	—	—	—	25.0	13.2	—	—	—	—	—	—	22.6	3.43	—	—	—	—
15.	—	—	7.1	2.86	4.7	18.58	1.1	22.87	—	—	—	—	—	—	—	2.9	2.86	—
16.	347.1	85.06	137.2	150.92	1.4	10.98	—	—	—	—	—	—	—	—	—	308.7	31.55	—
17.	381.4	94.66	561.8	271.65	20.9	174.24	—	—	—	—	—	—	13.7	4.12	—	238.7	15.09	—
18.	835.8	217.23	296.3	107.47	—	—	—	—	—	—	—	—	6.9	1.14	21.7	24.1	20.58	11.7
19.	—	—	402.0	145.43	27.6	97.41	—	—	—	—	—	—	—	—	—	—	—	—
20.	—	—	—	—	21.3	83.69	1.5	6.86	—	—	—	—	—	—	—	4.8	4.12	3.3
21.	—	—	7.2	5.14	64.3	260.67	—	—	—	—	—	—	—	—	—	—	—	14.1
22.	—	—	—	—	—	—	—	—	196.2	32.83	124.8	52.53	1.3	1.64	—	—	—	—
23.	115.9	38.41	381.4	163.26	—	—	2.1	12.35	—	—	—	—	—	—	46.0	—	—	2.1
24.	219.3	48.02	772.4	305.95	2.1	5.49	14.5	185.21	—	—	—	—	14.4	2.74	54.9	105.6	10.98	—
25.	236.0	48.02	541.9	262.04	2.7	5.49	23.3	96.03	—	—	—	—	—	—	—	82.3	8.23	—
26.	702.4	193.45	164.6	57.62	7.4	38.41	—	—	—	—	—	—	12.3	1.37	—	24.7	15.09	—
27.	1,483.4	349.80	—	—	18.0	65.16	—	—	—	—	—	—	17.2	3.43	—	1.7	1.71	—
28.	94.3	29.15	50.4	30.87	39.3	133.37	6.0	44.59	—	—	—	—	—	—	—	—	—	1.7
29.	—	—	26.0	8.67	11.1	57.80	—	—	5.8	1.44	281.8	59.24	7.5	2.89	—	—	—	—
30.	12.6	4.03	373.1	186.56	—	—	5.0	61.51	—	—	—	—	—	—	83.7	—	—	5.0
31.	531.6	158.92	716.8	302.97	26.6	42.30	13.6	75.46	—	—	—	—	—	—	8.0	2.3	2.29	2.1
32.	1,004.3	197.56	496.0	235.98	—	—	—	—	—	—	—	—	—	—	—	119.4	13.72	2.9
33.	2,503.8	515.86	75.5	45.27	3.7	13.72	—	—	—	—	—	—	—	—	—	233.2	28.81	9.6
34.	1,443.3	318.29	41.0	19.21	—	—	—	—	6.9	1.37	—	—	11.0	2.74	—	8.2	5.49	—
35.	71.3	20.60	13.0	13.72	63.78	71.34	—	—	—	—	—	—	4.1	1.37	—	30.9	8.23	5.5
36.	168.8	24.75	14.1	12.38	8.7	52.88	—	—	—	—	355.5	69.75	6.8	2.25	—	38.3	48.37	12.7
37.	143.2	29.58	538.4	150.29	—	—	3.2	14.20	—	—	—	—	—	—	13.0	—	—	3.6
38.	192.8	86.43	278.5	113.87	—	—	—	—	—	—	—	—	—	—	42.5	—	—	7.5
39.	212.7	61.74	163.9	107.01	—	—	0.3	4.12	—	—	—	—	—	—	—	43.2	15.09	2.3
40.	305.3	85.06	31.0	12.35	5.4	15.09	14.0	135.82	—	—	—	—	—	—	—	315.6	12.35	9.5
41.	78.9	9.60	6.9	5.49	2.1	38.41	6.7	71.3	—	—	—	—	—	—	—	157.8	32.93	71.6
42.	1.2	17.75	1.8	1.18	3.9	13.02	4.6	40.23	—	—	319.5	66.27	2.4	1.18	—	16.6	44.97	14.2
43.	105.8	14.87	15.2	7.87	1.0	3.50	2.1	26.24	—	—	—	—	—	—	11.4	—	—	24.8
44.	112.2	25.66	39.3	16.04	—	—	—	—	—	—	—	—	1.6	1.60	—	—	—	26.5
45.	54.6	7.80	23.2	17.54	4.1	19.50	2.0	40.22	—	—	—	—	2.9	0.97	1.7	24.4	3.90	10.9
46.	174.8	49.49	69.3	44.23	3.9	24.22	1.3	16.85	—	—	—	—	—	—	—	51.6	31.59	2.1
Total	12,418.7	2991.66	6895.3	3,068.4	664.7	2,004.66	115.2	948.43	314.3	63.08	1081.6	247.79	280.4	61.86	288.8	2,270.0	573.13	289.1

Placenta placenta (Linnaeus): This species (Pl. 3) ranked first with an estimated 12,420 t (approximately 300 million). Good beds of the windowpane oyster were observed in squares 33, 27, 34, 32, 18, and 26 in their order of abundance (Fig. 12). The highest density of 15.04/m² or 730g/m² was obtained in square 33 while at square 26 the density was 5.64/m² or 206 g/m². These 5 squares covering an area of about 17.1 km² sustained a population of 7,973 t or 64.2% of the total. In squares 31, 11, 17, 16, 40, 10 and 38 the oysters were less abundent; the density varied from 4.60/m² (155/gm²) to 2.48/m² (56 g/m²). These squares comprise an area of 22.7 km² and account for 2,511.2 t or 20.2% of the population. In other areas the windowpane oyster was either absent or it occurred in small numbers (< 2/m²). The spat was scarce. Young oysters measuring 17–42 mm were collected in squares 8, 16, 24 and 30. The overall length frequency (Fig. 13a) showed that the oyster measured 17 to 151 mm with dominant length groups in the range 87 to 118 mm.

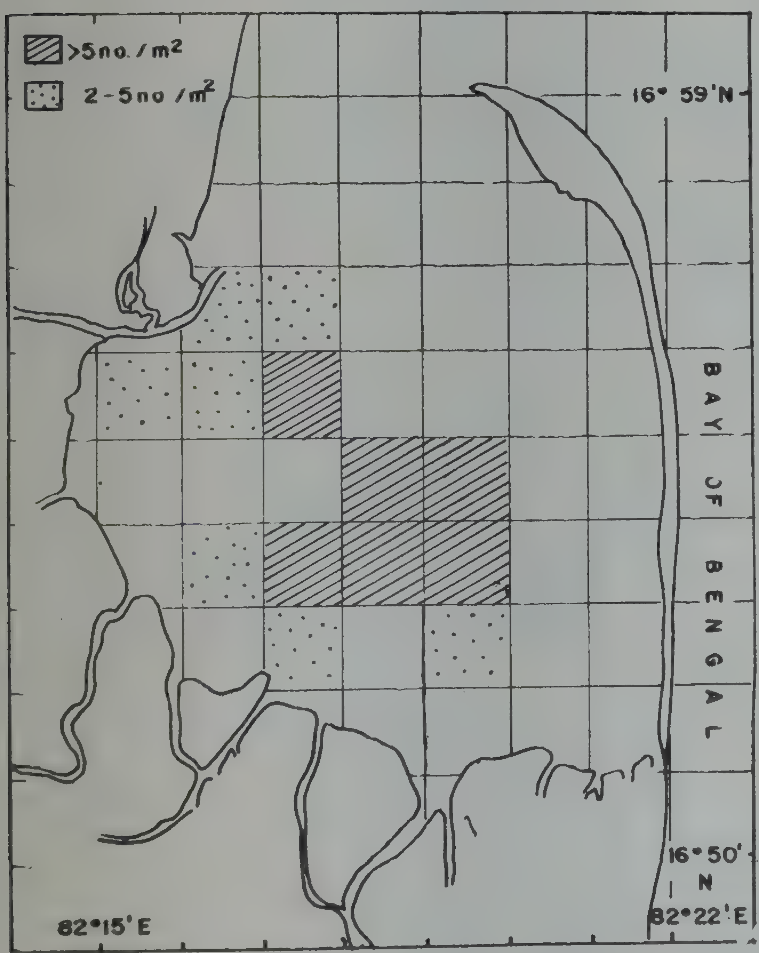


Fig. 12. *P. placenta* distribution in the bay.

Anadara granosa (Linnaeus): This species ranked second with 6,895 t and in numbers 307 million (Pl. 4). It was abundant along the western side of the bay (Fig. 14) in squares 24, 31, 17, 25, 37, 32 and 30 in their order of abundance. These 7 squares covering 22.6 km2 area accounted for 4,000 t or 58.0% of the blood-clam population. Their density varied from 9/m² (225 g/m²) in squares 24 to 5/m² (186 g/m2) in square 37. Considerable quantities of the clam were available in squares 19, 23, 18, 38, 11, 39 and 16 which covered an area of 24.0 km². These squares supported a population of 1,846 t which formed 26.8% of the total clam population. The density in these squares varied from 4.76/m² (111 g/m²) in square 23 to 2.40 /m² (54 g/m²) in square 11. In other squares either there were no clams or their population was below 2/m². Their length varied from 15 mm to 63 mm (Fig. 13d) with dominant size groups at 25–45 mm.

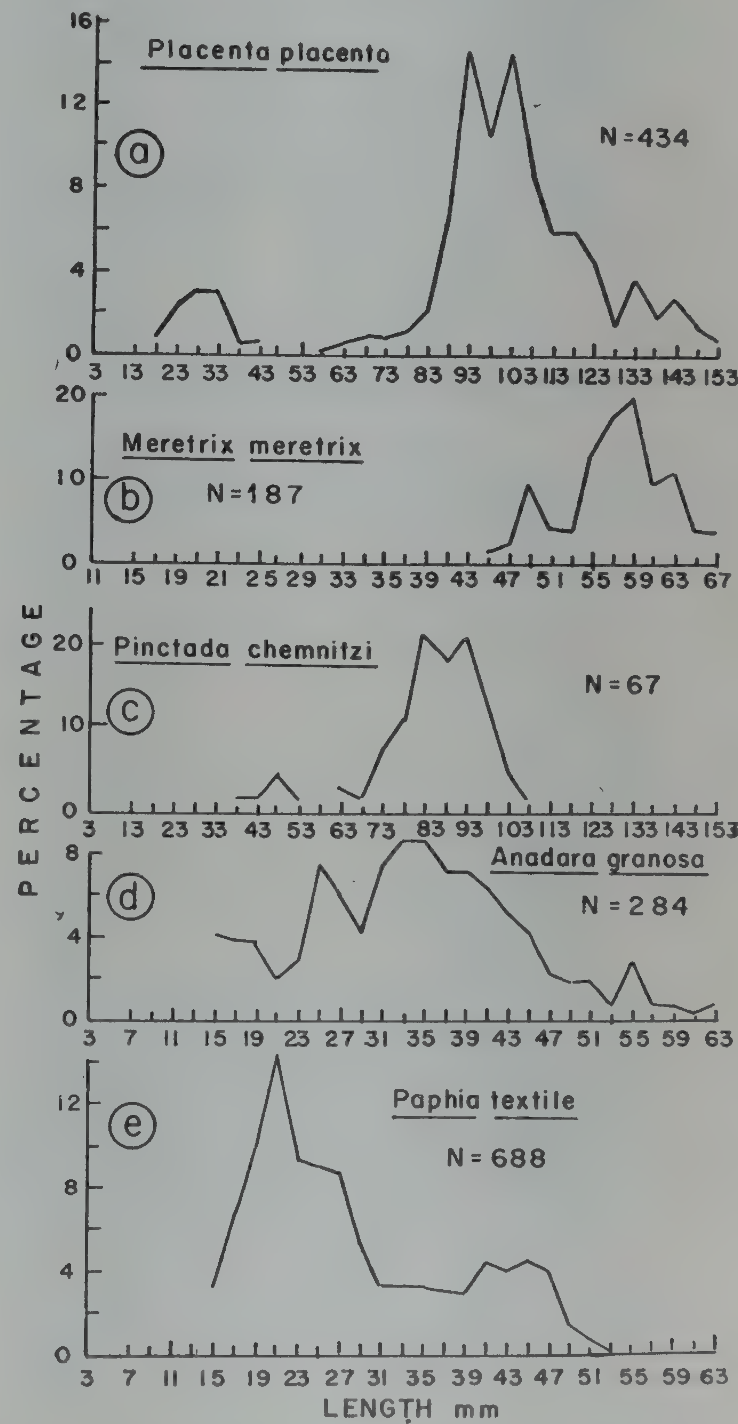


Fig. 13. Length frequency distribution of some bivalves collected by the dredge in the bay.

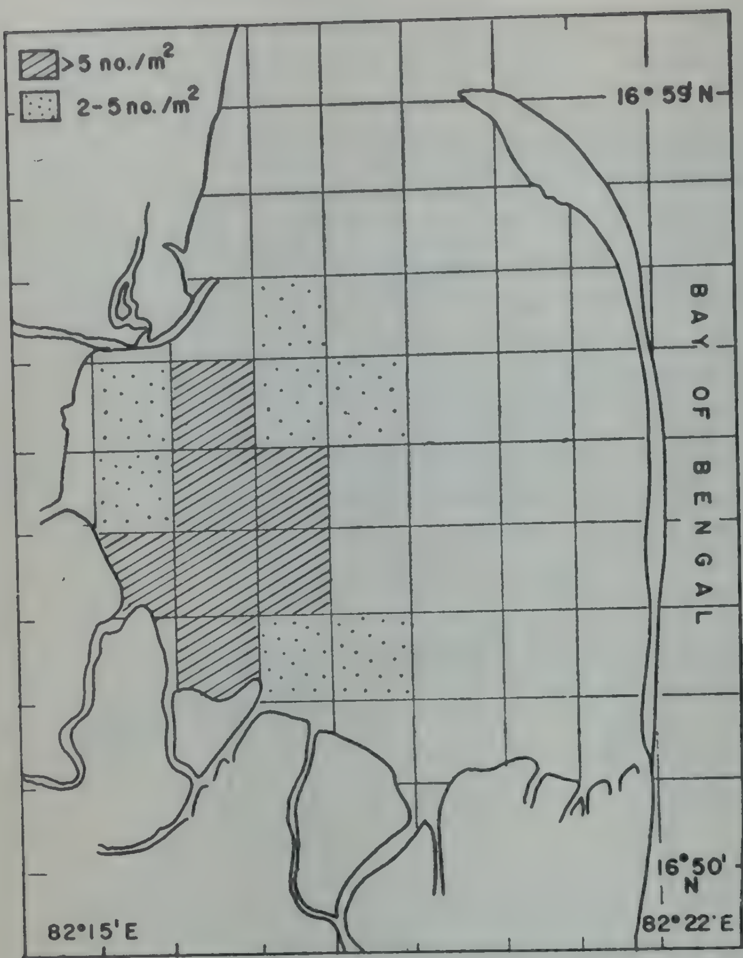


Fig. 14. A. *granosa* distribution in the bay.

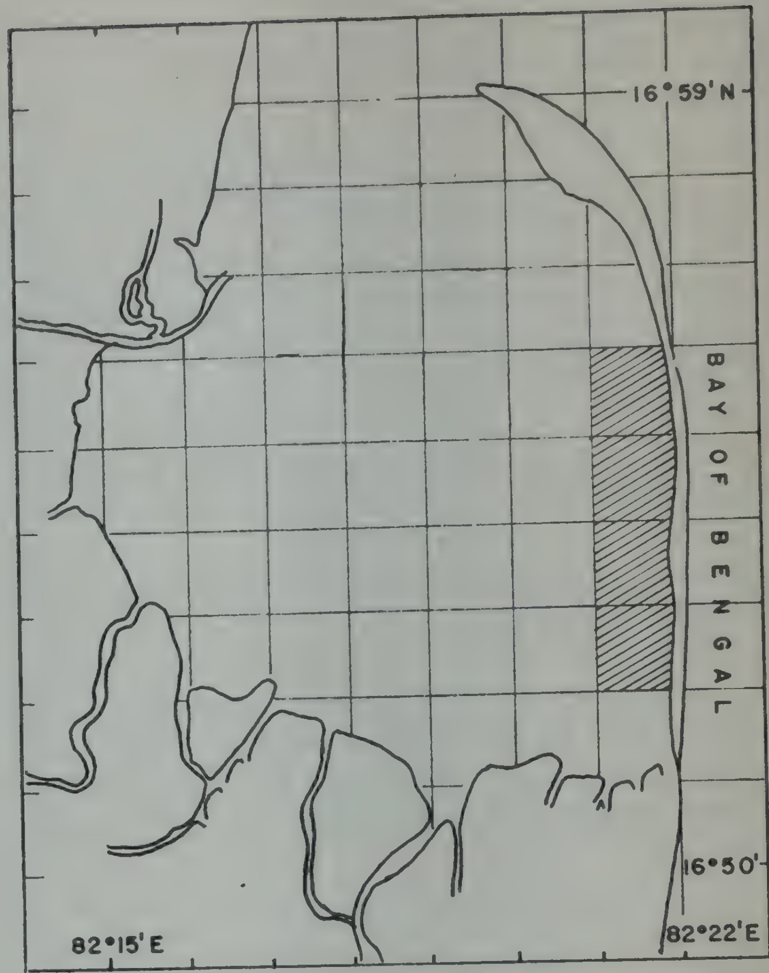


Fig.. 16. *M. meretrix* distribution in the bay Stripes indicate the squares where this species is available.

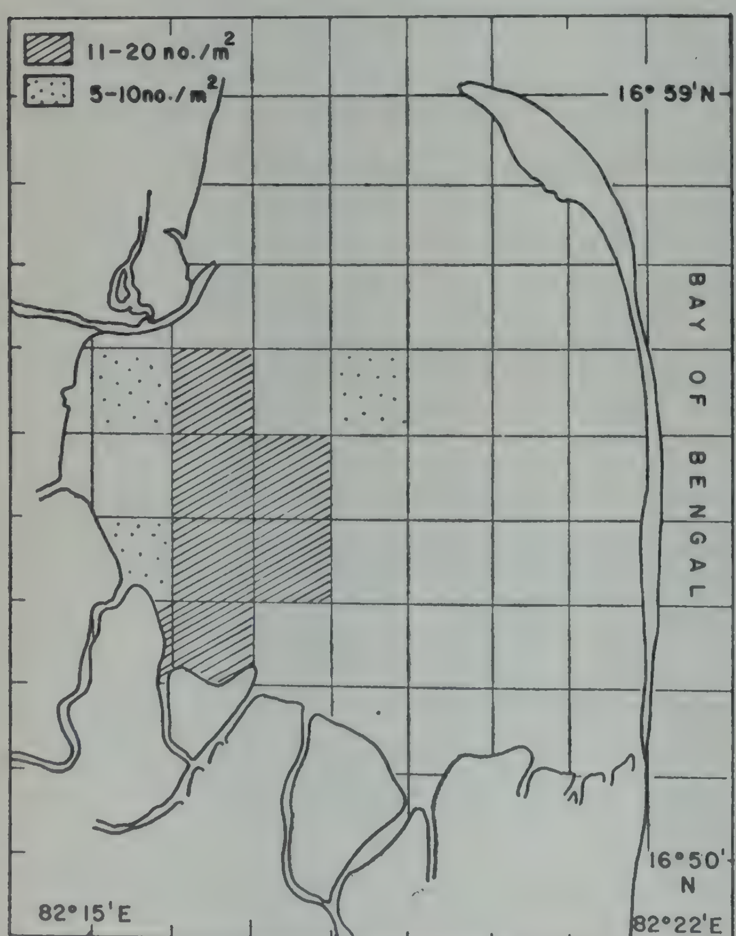


Fig. 15. A. *granosa* seed availability in the bay.

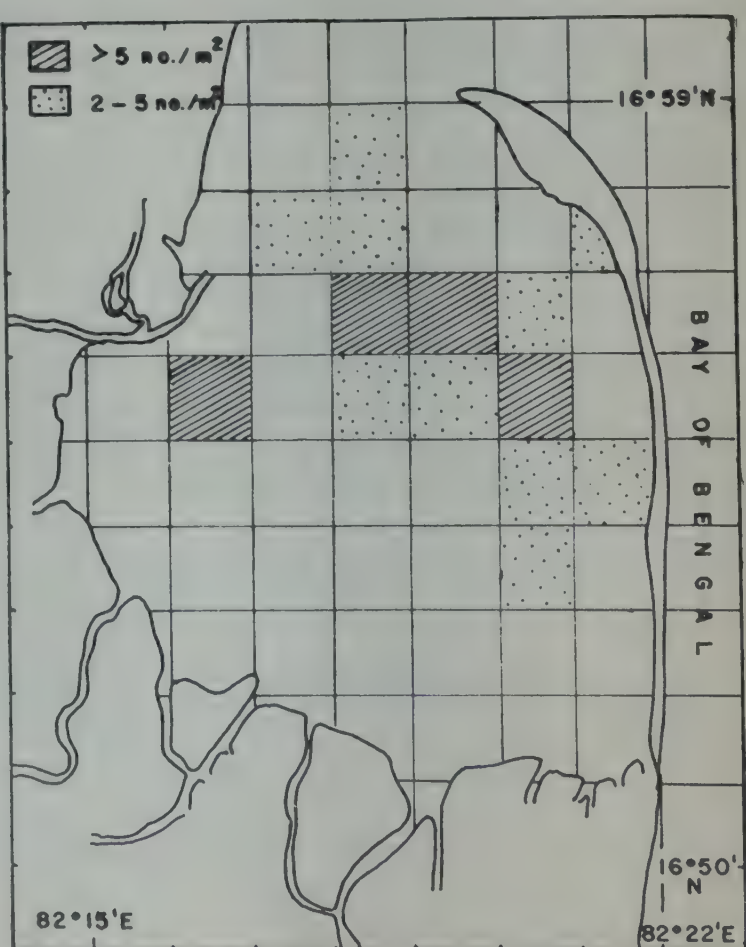


Fig. 17. *P. textile* distribution in the bay.

Seed resources of A. *granosa*: All the clams collected by the clam seed sampler were included here. Their length varied from 4 to 59 mm. However, vast majority of them (71%) were < 25 mm which is the size used in experimental culture (Narasimham, 1980). The distribution of the seed is limited to the western side of the Bay (Fig. 15) and is within the area where the adult population occurs. The density was high in squares 31, 24, 17, 37, 253 2and 16. It varied from $19/m^2$ in square 31 to $11/m^2$ in square 16. The Van Veen grab genrally gave a lower density of the bloodclams and this is probably due to the fact that very small area was sampled by the grab.

Meretrix meretrix (Linnaeus): This species (Pl. 5) ranked third among the molluscs and occurred at 4 squares *viz.* 36, 42, 29 and 22 along the eastern side of the bay (Fig. 16). The population was estimated at 1,082 t. The density was low and varied from $3/m^2$ ($126\ g/m^2$) in square 36 to $2/m^2$ ($43\ g/m^2$) in square 22. The size ranged from 45 to 67 mm with 55–63 mm group dominating (Fig. 13b).

Paphia textile (Gmelin): This species (Pl. 6) was distributed in major part of the northern section of the Bay. The population was estimated at 665 t (200 million) and it was abundant in squares 21, 13, 12 and 17 (Fig. 17). These squares covered an area of 13.7 km^2 and accounted for 42.0% of the population. Their density varied from $8/m^2$ in squares 21 to $5/m^2$ in square 17. In squares 28, 14, 6, 19, 7, 20, 9a, 3, 35 and 29 the density was low and varied from $2/m^2$ (in square 29) to $4/m^2$ (in square 28). These 10 squares covered an area of 31.2 km^2 and accounted for 38.3% of the population. Their length varied from 14 to 52 mm and 17–29 mm clams were dominant (Fig. 13e).

Seed resources of P. textile: The clams collected by the seed sampler varied in length from 3 to 48 mm and majority of them (66.2%) were < 20 mm in length. The seed occurred in the northern and eastern parts of the bay. Very high densities of $80/m^2$ in square 12, $39/m^2$ in square 35 and $31/m^2$ in square 42 were obtained (Fig. 18). In squares 3, 11, 8, 1, 36 and 28 moderate densities which varied from $16/m^2$ (square 3) to $11/m^2$ (square 28) were recorded. Seed occurrence was low in squares 21, 17, 34, 33, 2, 6, 5, 13, 26, 27, 9, 41,14, 15 and 22 which varied from $10/m^2$ (square 21) to $5/m^2$ (square 22). Generally seed was available in much larger area when compared to the distribution of adult population.

Pinctada chemnitzii (Philippi): The population was estimated at 314 t (6.3 million) and was limited in distribution to squares 22, 9, 34 and 29. They were found attached among them and to dead windowpane oyster shells (Pl. 7), in groups of 3 to 16 forming a lump. Within the square their distribution was patchy. They measured 37 to 106 mm (antero-posterior axis) and 73–98 mm oysters were dominant (Fig. 13 c).

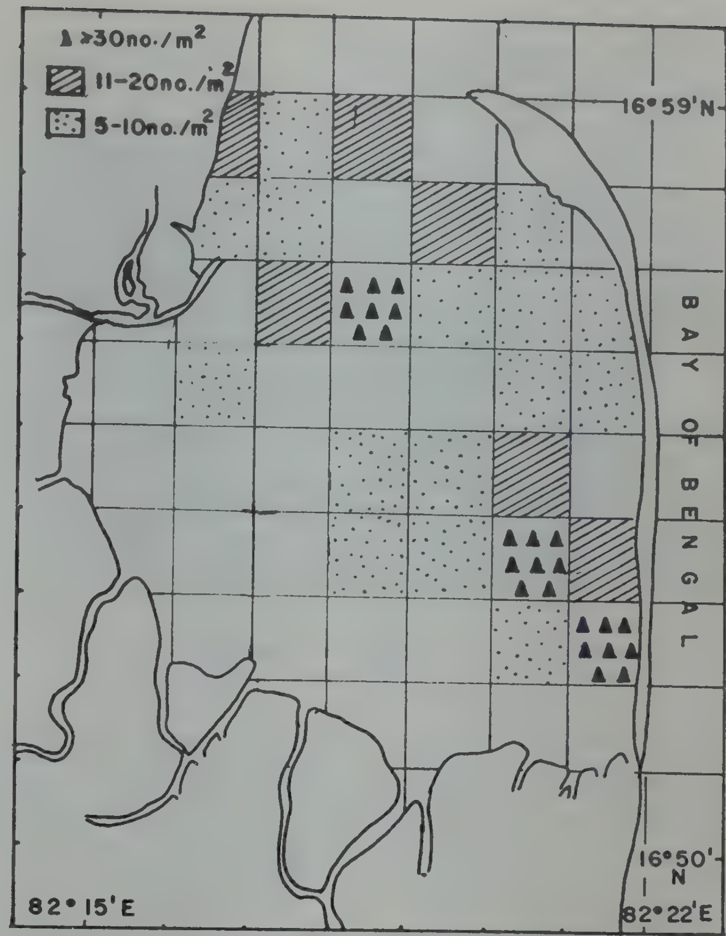
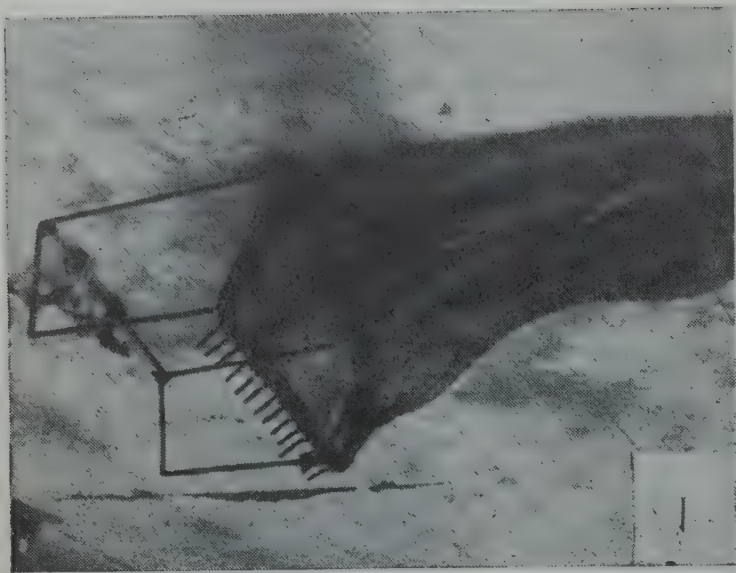


Fig. 18. *P. textile* seed availability in the bay.

Tellina spp: The resource was meagre at 115 t and was available in squares 25, 24 and 31. The size varied from 14 to 28 mm and because of the brittle shell and small size, the species does not have a fishery potential.

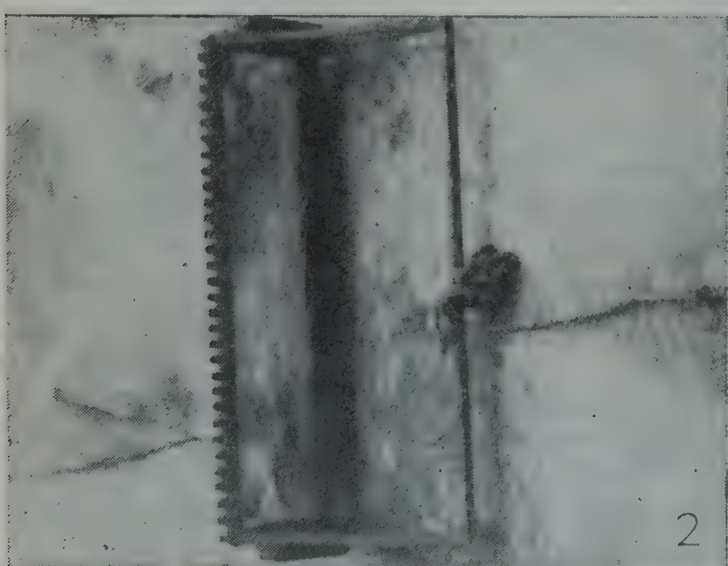
Hemifusus pugilinus (Born): This gastropod resource was small at 280 t and was mainly encountered in squares 4, 14, 13 and 7. It measured (apex to lower opercle edge) 28 to 98 mm in length. The opercle of this species finds use in the Unani system of medicine and is priced at 30 paise a piece locally while the shell is used in lime preparation.

Crithidea fluviatilis (Potiez and Michaud): An estimated 289 t was available in the bay. Their distribution was mainly confined to squares 30, 24, 23 and 18. This species measured (apex to lower opercle edge) 17 to 24 mm in length.



Pl. 1. The 0.5 m dredge

Other species: Fairly rich beds of *Modiolus* sp. were present in squares 10, 23, 38, 41 and 44. Polychaetes were abundant in squares 13, 14, 21, 25 and 32 and they often clogged the dredge. Large concentration of *Umbonium gestiarium* (Linnaeus) was encountered is square 9a. Mostly they passed through the dredge (Length 4–12 mm) but were collected by the seed sampler. Other species caught in stray numbers were *Katelysia opima* (Gmelin), *Donax* spp, *Telescopium* (Linnaeus) and *Paphia malabarica* (Chemnitz).



Pl. 2. The 0.5 m clam seed sampler

Holothurian resources

Acaudina molpadioides (Semper): The resource was estimated at 2,270 t and was abundant in squares 3, 40, 16, 17 and 33. It measured 20–160 mm.

Shell resources

The shells of molluscs remaining on the bed or superficially covered (upto 10 cm depth) by the sediment after death are dealt here under shell resources as distinct from subfossil shell deposits which may extend upto a few meters depth. The total shell resources were estimated at 21,097 t (Table 4).

Placenta placenta: The shells of this oyster were estimated at 8,200 t and they occurred in all the squares except 3, 4, 13 and 15. The shell was available in considerable quantities in squares 27, 31, 29, 16, 36, 18 and 34. The distribution is similar to the live population except for its presence in squares 29 and 36.

Anadara granosa: An estimated 1,817 t of shell was present. Major areas of abundance were squares 16, 24, 18, 32 and 25 which agrees with the distribution of live clams.

Other shells: Excepting the shells of the window-pane oyster and the blood-clam, the shells of other species dealt under the live resources were estimated at 1,1062 t. They were abundant in squares 4, 6, 13, 35, 12, 18, 11, 7, and 5. Their concentration in the northern section of the bay, which is generally poor in live populations, except for *P. textile,* suggests that the shells are probably carried by the currents.

Molluscan resources of the Kakinada canal

This irrigation cum navigation canal, originating from the Godavari river, opens into the bay at Kakinada. The banks are made by concrete structures and estuarine conditions prevails upstream upto 5 km length of the canal from the mouth. The concrete banks extend into the bay and harbour rocky fauna both on the inner canal side and outer bay side. The extent of its concrete banks and the estimated oyster population are given in Table 5.

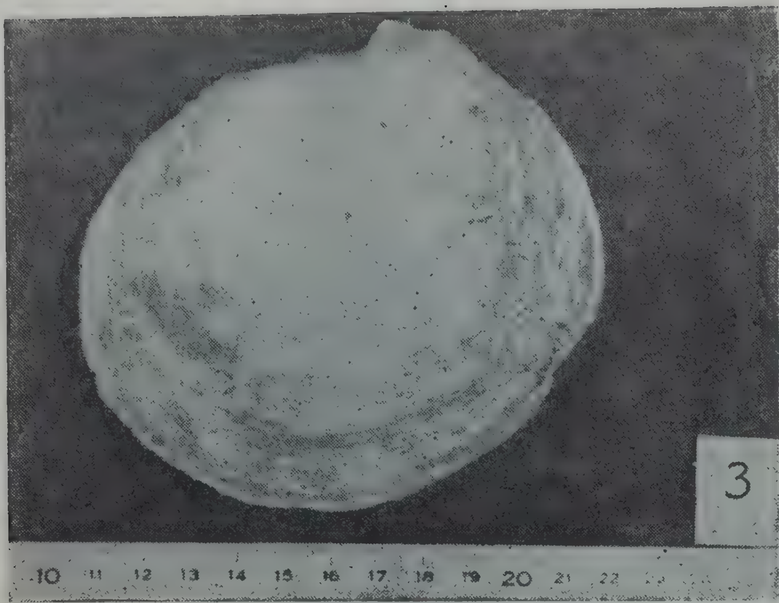
Oyster resources: The average width of the banks inhabited by the oysters is 3 m and except the bay side of the left bank the oyster bed extended upto a distance of 2.3 km upstream. However, the density of the oysters was high close to the mouth of the canal. The total spread of the oyster bed is 2.25 ha and the estimated weight of the population is 90 t (11.7 million) which gave a density of about 40 t/ha. At many sampling stations there was a thick mat of oysters and a maximum of 1,882/m^2 were counted. The rock oyster *Saccostrea cucullata* (Born) formed a negligible proportion (nil to 5.5%) while *Crassostrea madrasensis*

Table 4. *Abundance of shells in the Kakinada Bay (in tonnes)*

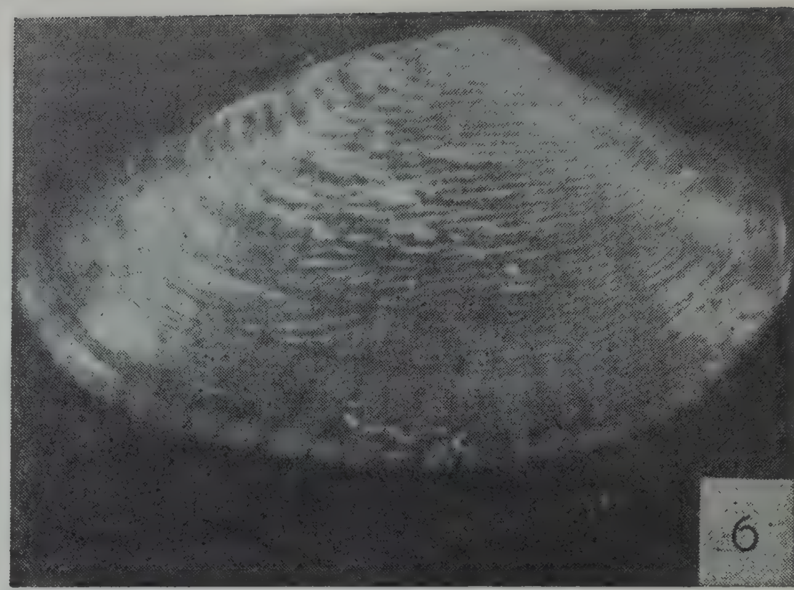
Square No.	*Placenta placenta*	*Anadara granosa*	Others	Square No.	*Placenta placenta*	*Anadara granosa*	Others
1.	12.2	18.6	156.4	24	178.4	356.7	157.8
2.	20.0	11.4	24.0	25	205.8	117.3	260.7
3.	—	—	10.3	26	196.5	17.2	94.7
4.	—	—	1,431.9	27	737.4	8.5	47.2
5.	30.5	34.7	405.3	28	214.4	11.1	61.2
6.	15.4	15.4	903.2	29	578.0	3.6	218.6
7.	102.9	—	419.1	30	26.5	14.1	222.9
8.	20.6	—	119.2	31	679.1	33.2	14.9
9.	286.5	—	107.6	32	149.5	134.3	159.8
9a.	26.3	—	16.1	33	133.1	12.5	144.1
10.	205.0	38.8	231.3	34	347.8	—	331.3
11.	219.5	27.4	592.0	35	46.6	—	702.4
12.	354.4	8.0	662.7	36	436.5	6.0	186.2
13.	—	—	788.9	37	26.0	—	156.2
14.	21.4	—	320.7	38	98.9	19.3	34.3
15.	—	—	13.0	39	105.0	37.0	71.3
16.	493.9	473.3	75.5	40	226.4	3.8	51.8
17.	37.0	34.3	150.9	41	188.1	35.0	128.6
18.	380.7	174.9	646.5	42	75.7	35.5	127.8
19.	225.3	38.4	119.1	43	95.1	3.0	6.0
20.	221.6	1.4	35.7	44	166.8	20.8	77.0
21.	169.8	6.3	262.4	45	21.2	8.1	11.7
22.	262.6	—	26.4	46	121.7	5.8	34.7
23.	57.6	51.4	242.8				
Total:					8,217.7	18,17.1	1,10,62.2

Table 5. *Edible oyster resources of the Kakinada canal*

Sl. No.	Extent of bed	Range in nos/m² (Average)	Range in weight kg/m² (Average)	Estimated number for the bed	Estimated wt. kg for the bed	Species composition by numbers
1.	Left bank, bay side 1,800 m²	818–1,860 (1,510)	2.90–7.40 (5.82)	27,18,000	10,476	*S. cucullata* 3.9% *C. madrasensis* 96.1%
2.	Left Bank, canal side 6,900 m²	100–1882 (858)	1.20–7.50 (3.63)	59,20,200	25,047	*S. cucullata* 5.5% *C. madrasensis* 94.5%
3.	Right bank, canal side 6,900 m²	154–228 (200)	3.14–4.80 (4.18)	13,80,000	28,842	*S. cucullata* 0.8% *C. madrasensis* 99.2%
4.	Right bank, bay side 6,900 m²	112–384	2.6–4.4	16,56,000	25,530	*C. madrasensis* 100%
Total:	2.25 ha	—	—	1,16,74,200	89,895	

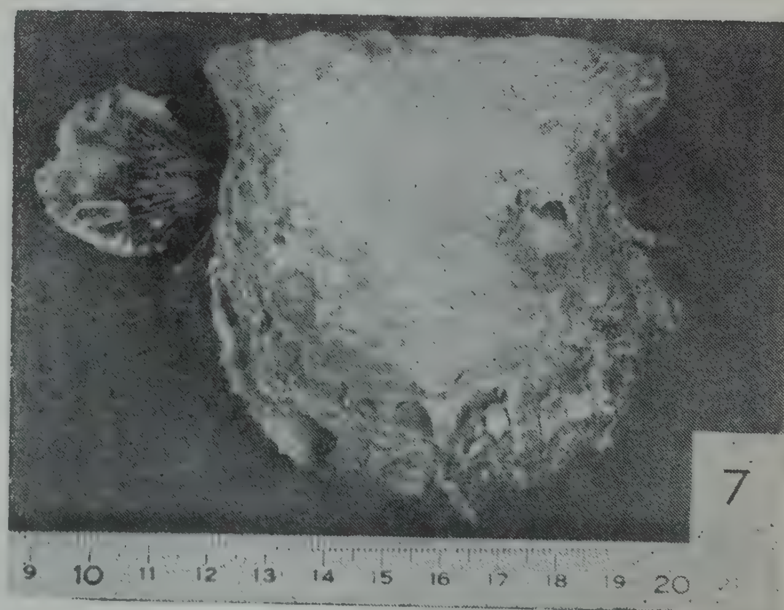


Pl. 3. *Placenta placenta*

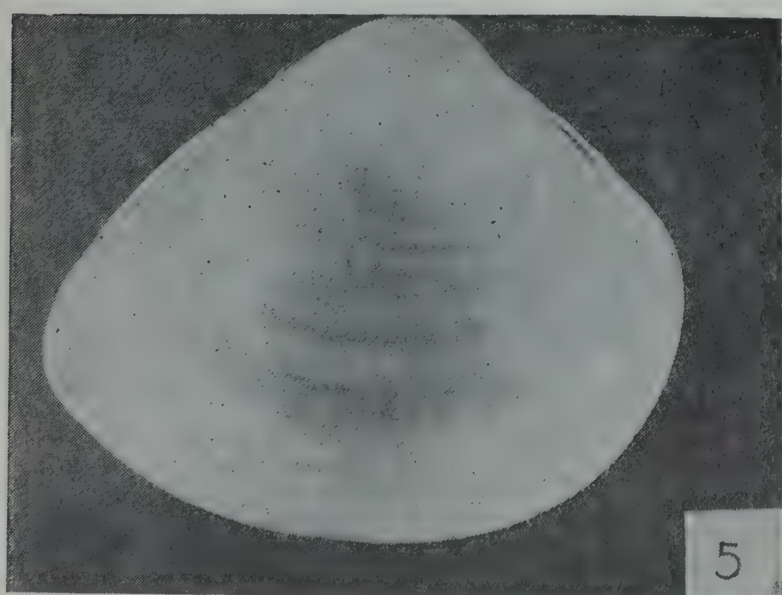


Pl. 6. *Paphia textile* (48 mm)

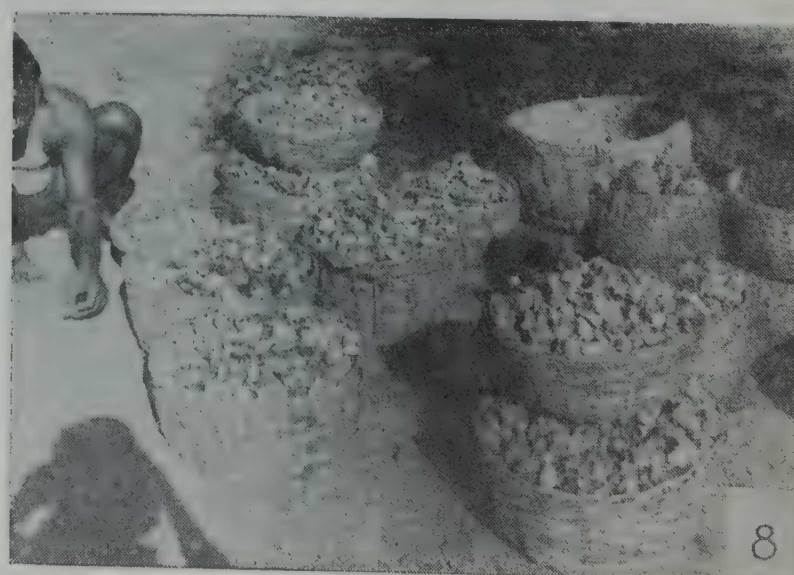
Pl. 4. *Anadara granosa*



Pl. 7. *Pinctada chemnitzi*



Pl. 5. *Meritrix meretrix* (66 mm)



Pl. 8. Oysters in the market.

(Preston) was dominant (94.5 to 100%). It varied in length (dorso-ventral axis) from 7 mm to 142 mm and majority measured below 30 mm in length.

Perna viridis (Linnaeus): This species occurred in patches along with the oysters closer to the low water mark. The total area inhabited by the mussel is 0.75 ha. Density varied from nil to 12/m2 with an average of 1/m². A total of 586 kg of mussles (7,650) were estimated to be present. They varied in length from 68 to 137 mm.

Discussion

The studies by Rao (1967) indicate that more than 60% sand occurs opposite the Gaderu confluence, a small patch south of the Kakinada canal and along the western side of Hope Island. The present observations agree with the above but show that the northern section of the bay is also predominantly sandy. Sediment analysis of the natural beds of *A. granosa* in Malaysia (Pathansali, 1964) showed, barring one exception, that more than 95% of the particles were less than 0.124 mm; particles < 0.031 mm constituted 63 to 87%. The results obtained by him on culture beds were comparable to the natural beds but the particles < 0.031 mm were generally much less (25–79%). In the present study *A. granosa* and *P. placenta* were generally abundant in areas where more than 50% of the sediment particles were < 0.125 mm. It is well known that the pediveliger larvae of bivalves delay metamorphosis until the conditions are suitable for settlement (Wilson, 1958). The availability of substratum with finer particles which is rich in organic carbon seems to be an important factor limiting the distribution of these two species. On the other hand *P. textile* and *M. meretrix* occurred in considerable numbers in areas where the particle size of the sediment was coarse (>0.125 mm).

Rao (1967) observed that the organic carbon in the sediments was the highest (> 1%) in the tidal flats along the western side of the bay and lowest (< 0.4%) in the sands of the Gaderu confluence. He noted that the organic carbon was high in sediments of finer particle size than in coarser sediments. The results obtained in the present study are generally in agreement with the observations of Rao (1967).

Radhakrishna and Ganapati (1967) observed that *A. granosa* and *P. placenta* were restricted in distribution along the western and southern side of the Bay. The present study indicates considerably wider area and also overlapping in the distribution of these two species than what their figure 2 indicated.

Narasimham (1973) estimated the annual landings of *A. granosa* at 1,000 t and *P. placenta* at 4,000 t out of a total catch of 6,000 t of molluscs from the Bay. Recently Silas *et al.* (1982) gave the annual production of *A. granosa* in the bay as 2000 t. The present estimate of 6900 t of blood-clam in the Bay suggests that the resource is extremely limited. Since the blood-clam is a sedentary organism it becomes easily vulunerable to over fishing when the demand for its meat increases due to an export potential. Further its distribution is limited to shallower region, not exceeding 2.2 m depth. Techniques for the culture of *A. granosa* in the Bay were developed (Narasimham, 1980) which gave very encouraging results with regard to growth, survival and production. However, the seed resources in the Bay are not abundant (density below 20/m²) and cannot be depended upon for large scale clam culture. The only alternative is to go in for hatchery production of seed. Realising this the Central Marine Fisheries Research Institute is working on a project at Kakinada for the controlled production of the seed of *A. granosa*.

Murthy *et al.* (1979) estimated the live population of *P. placenta* in the Bay at about 9,000 t and dead oyster shell at about 43,000t. The present study indicated the live windowpane oyster resource at about 12,500 t and the gap between the present catch and the potential is narrow.

In the case of *M. meretrix* also the gap between the present catch of 400 t and the estimated resource at 1,080 t is narrow. *P. textile* is not exploited at present as it is distributed in the northern section of the Bay, in slightly deeper waters and is beyond the reach of the fishermen who collect the molluscs in the Bay at low tides by hand picking without any diving aids. It needs to be investigated whether the holothurian *A, molpadioides* has any economic importance.

We thank Dr. E. G. Silas, Director for suggesting the problem and encouragement, Dr. K. Alagarswami, Scientist S–3 for suggesting improvements and Shri G. P. Kumaraswami Achari, Scientist for giving the design of clam seed sampler. It gives us pleasure to acknowledge our gratitude to Shri Ch. Ellithathayya, T-1 and Shri J. B. Varma, T-1 who rendered considerable assistance in many ways.

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BUMBER CATCHES OF PRAWNS, POMFRETS, LITTLE TUNNIES, BLACK SHARKS AND OTHER FISHES AT KARWAR*

Purse seine catches

In 1982, at Karwar, the purse seine boats commenced fishing from 1st of September. A new pattern of fishing was evident from the beginning of the season. Because of lack of oil sardine and mackerel shoals the seiners were forced to scan deeper waters which resulted in exceptionally heavy catches of *Thrissa,* barred longtom *(Ablennis hians)*, seer fishes, little tunny *(Euthynnus affinis)* leather skin *(Chorynemus sanctipetri)* and black pomfret hitherto not known for such quantities in this part of coastline. Besides, bumper catches of prawns *Metapenaeus dobsoni* amounting to about 39 t were hauled up. It is said that such quantities of prawns were never recorded in the past by the purse seiners at Karwar eventhough the seiners were in operation here for more than half a decade. The catch details on weekly basis for September and October are given in Table 1.

The catch of *Thrissa* amounted to 75.4 t whereas barred longtom was about 8 t. Bumper catches of little tunny in mature condition mostly caught in north-west region of Karwar in depth of 40–75 m (Cancona area) were landed between 26th September and 23rd October. As high as 42.6 t of this species was landed on 8th October alone. Weight of each fish ranged from 1 to 3.15 kg.

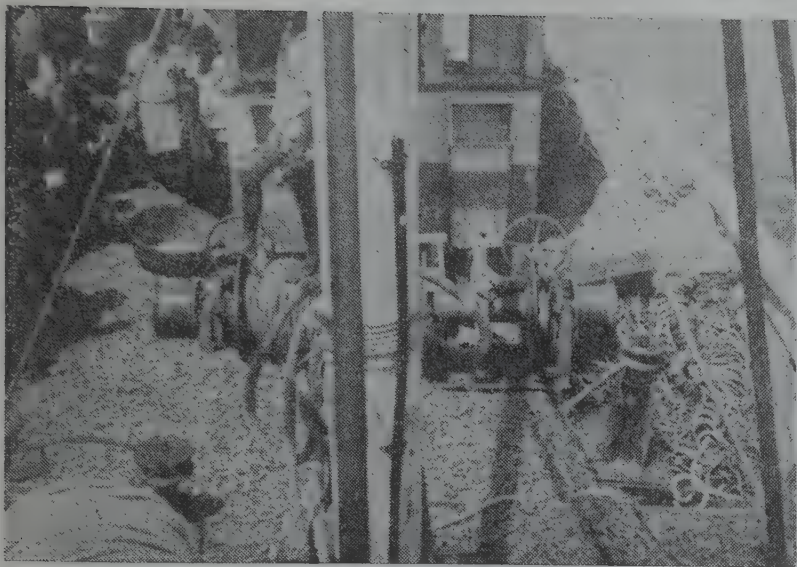
The estimated catch of *Scomberomorous commersoni* and *S. guttatus* amounted to 21.8 t of which 20 t alone were landed on 21st and 22nd September. The former species accounted for more than 75% of the catches.

Unprecedented catches of black pomfret *(Parastromateus niger)* were made between 22nd and 31st October, mostly from the region between Karwar and Belekeri in the south, in the depth range of 40–60 m. On 29th October, the catch of this fish amounted to as high as 109.5 t an all time record in the annals of Karwar. Similarly dolphin fish weighing 28.5 t were landed on 26th October; of course, a rare sight by itself.

The local as well as neighbouring markets could not consume all these huge catches which naturally caused glut conditions on most of these days. Nevertheless, the distress sales were avoided because of heavy demand from the southern regions. The Karnataka Fisheries Development Corporation purchased most of the catches of seer fishes and black pomfret which in fact rescued fishermen from financial loss.

* Prepared by M. H. Dhulkhed, G. G. Annigeri, G. Nandakumar and D. Y. Naik

Important purse-seine catches



Metapenaeus dobsoni

Barred longtom (*Ablennis hians*)

Black pomfrets (*Parastromateus niger*)

Black shark (*Carcharinus melanopterus*)

Little tunny (*Euthynnus affinis*)

Dolphin fish

Table 1. *Catch details of prawns, pomfrets, little tunnies and others (in kg) in purse seiners at Karwar*

Date	Prawns (M.d.)	*Thrissa*	*Ablennis hians*	Tunny	Seer fishes	Black pomfret	*Chorinemus*	*Coryphaena*
1st–4th Sept.	8,400							
5th–11th ,,	20,225	14,060						
12th–18th ,,	10,185	44,100						
19th–25th ,,	22	15,500	1,000		20,030			
26th–30th ,,		35	375	12,000			15,020	
1st–2nd Oct.				12,900				
3rd– 9th ,,			6,600	1,11,950	170	300	490	
10th–16th ,,		700		24,700	1,600	1,230	420	
17th–23rd ,,		1,000		90		48,500		33,600
24th–31st ,,						4,00,660		
Total	38,832	75,395	7,975	1,61,640	21,800	4,50,690	15,930	33,600
R	71–125	110–169	825–1,272	400–680	400–610 (S.g.) 410–770 (S.c.)	100–450	220–370	210–460
M	93, 103	120, 150	—	410, 490, 510, 640 & 680	460, 510 (S.g.) 720 (S.c.)	110, 200 240 & 290	320, 340	330, 380 & 430
Price	Rs. 13/kg	Rs. 20–30/ 40 kg	Rs. 200–300/100 Nos.	Rs. 0.50–5/fish	Rs. 3/kg	Rs. 1.25–6/kg	Rs. 150–200/100 Nos.	Rs. 250/ 100 Nos.

R: Range in mm, M: Mode in mm, S. g.: *Scomberomorus guttatus, S. c.: Scomberomorus commersoni,* M.d.: *Metapenaeus dobsoni.*

As there is practically no market for tuna, they were packed in ice and transported to different parts of Kerala. Even then some catches could not be disposed off. For the first time at Karwar little tunny weie to be diverted for salt curing.

Leather skin and dolphin fish were purchased by merchants to be taken to southern states where they command better prices.

Hooks and lines catches

The few fishermen who practiced hooks and line fishing in the Karwar area had to leave this profession with the advent of purse seines. Dug-out canoes fitted with inboard/outboard engines which operate drift nets added to their agony still more. However, a few enterprising fishermen have started going for hooks and lines fishing in the mechanised boats (10 m) from September onwards. On 25th of September three units landed five tonnes of black sharks *(Carcharinus melanopterus)*. Nevei before such a quantity of sharks was landed at Karwar. Their size ranged from 60 to 250 cm. Majority of them were males. Tht fishermen realised Rs. 6,500/-. The sharks were taken to Mangalore for extraction of oil and curing.

Due to inclement weather these units did not go out for fishing subsequently. Neveitheless, it appears that in coming months the hooks and lines fishing may revive in this area.

EARNING BY LEARNING AND DOING*

Prawn farming is no longer a myth to the poor landless harijan farm labourers of the coastal villages of Ernakulam and adjoining Districts. Traditionally, prawn farming has been a monopoly of the rich, and the poor landless farm labourers are engaged by them for farm labour. Taking a prawn farm on lease for prawn farming needs high investment in terms of lease value of the field which an ordinary farm labourer cannot afford. CMFRI has been able to implement a much simple method of Scientific prawn farming which could be done even in small canal systems in coconut groves.

Mr. Satyan, a harijan youth belonging to Kuzhuppilli, a remote village in Vypeen island lying at the coastal belt of Ernakulam District is one among the many landless labourers who are beneficiaries of the newly developed technology.

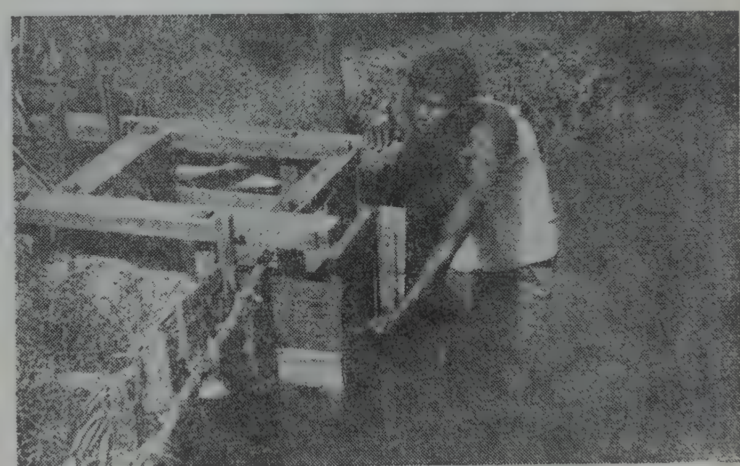
Satyan hailing from a family of 8 members is aged 23. He has studied up to eighth standard. The annual income of the family is around Rs. 1,800/-. Fishing and farm labour are the major sources of income. Satyan underwent the short-term training course on prawn farming conducted by the Krishni Vigyan Kendra of CMFRI at Narakkal in April 1980. Really this marked a turning point in his life. He was very much impressed by the feasibility of growing commercially important species of prawns in the canal systems. In the vicinity of his house his land lord is having a coconut grove of 1.5 acres with a canal system of about 52.5

Pl. 1. The prawn farm that provides livilihood for Mr. Satyan. All but some water logged canals in a coconut groove.

cents (2,100 m^2). This highly potential water area was left unutilized till Satyan, the enthusiastic youth stepped into it. During his training period itself he had made up his mind to try the new technique in this canal system. Meanwhile he approached the landlord and explained his ambition. Satyan, so trustworthy a youth had no difficulty in winning the confidence of his landlord and generously enough the landlord Mr. Moideen Haji released the water area to Satyan free of cost for growing prawns. Thus even before completing the training course he got the water area at his disposal. The staff of KVK visited the site and ascertained the suitability of the canal system for the purpose.

Soon after completing the training he embarked upon the ambitious programme. He got the fullfledged support of his father and two brothers who joined hands with him in accomplishing the culture operations.

Deepening and shaping of the canals were done by his own family members. Predatory organisms present in the water were fished out using cast net, drag net and bag net (*vattavala*). By the end of November the canals were ready for stocking. Juveniles of the



Pl. 2. "The gate way of prosperity" Mr. Satyan at work at the sluice gate of his prawn farm.

fast growing Indian white prawn *Penacus indicus* were collected from shallow brackishwater canals at Chathanadu, Pallippuram and other nearby places. Prawn seeds were transported to the culture site by country canoes. Plastic buckets and earthern pots were used as containers. Stocking was over by mid-December. A total of 9,500 juveniles ranging in size 30–60 mm were stocked. Growth studies were done regularly by sampling method. The staff of KVK paid frequent visits to his farm and monitored the culture work. By the end of March the prawns attained marketable size and harvesting was advised. Harvesting was done in presence of the KVK staff. It was also witnessed by a large gathering of local farmers and landless farm labourers. To the surprise of the crowd waiting, Satyan

* Prepared by: K. Asokakumaran Unnithan, P. K. Martin Thompson and P. Radhakrishnan

and his associates netted out 68 kg of *naran (P. indicus)* fetching an amount of Rupees 2,100/-.

Encouraged by his first venture he followed the same operation during the following year, 1981. During this period two crops were taken, mid-November to mid-February and early March to early June. During the year 1983 another technique of farming was tried. This method involved intermittent stocking and harvesting. Here, a partial harvesting was done after 2 months of first stocking, taking out only the marketable sized ones. Followed by the partial harvesting, juveniles at the rate of double the number of prawns harvested were stocked again. Thenceforth every month there was a partial harvesting and stocking as above. This practice was continued till the onset of monsoon.

Satyan feels that this method of intermittent stocking and intermittent harvesting is superior to single stocking and single harvesting method. The former would provide opportunities of realising income at frequent intervals whereas in the latter method one would have to wait for 3 months to get the return. Another advantage of this method he explained is that the commercially most important species of prawn *Penacus monodon,* which needs relatively longer period of culture could also be stocked along with *P. indicus* since this method allows a prolonged duration of culture. *P. monodon* could be retained in the canals even during the monsoon period since it has more tolerance to low salinities.

During the last prawn culture season November '82 to April '83 he successfully tried this type of culture. A total of 5,000 numbers of *P.monodon* and 7,000 numbers of *P. indicus* were stocked at different intervals during November '82—March '83 period. Harvesting was done intermittently from February to April '83. He got 35.75 kgs of *P. monodon* and 53.5 kg of *P. indicus* fetching a total of Rs. 2,685.40.

During this culture operation his prawn stock suffered substantial mortality due to "softness". As soon as he noticed this phenomenon he conveyed the matter to KVK. Soon Scientists and Technicians of the Institute visited his farm and advised immediate harvesting. But for this heavy loss his income would have been much better, Satyan concluded.

Meanwhile his landlord had also become very much convinced by this low cost technology of prawn farming. Impressed by the immense potentiality of his canal system he expressed his desire to have a share of the income. Satyan was only happy to part with a part of his profit. Since last year he has been paying an amount to his landlord towards the lease value of the water area.

Now Satyan is fully confident. He would be able to get some return from the venture at any time of the year. He has taken up prawn farming as a full time occupation which provides a steady and satisfactory livelihood. Encouraged by the feasibility of the technique he is planning to take a larger field on lease for scientific prawn farming, next year.

Establishing a peeling shed was a long cherished dream of Satyan. Thanks to the Department of Harijan welfare—Satyan is getting a loan of Rs. 8,000/- for this purpose. The continuous association he had with prawn farming has helped him a lot in convincing the financing agency. One of the main constraints that he confronts is the inadequacy of natural prawn seed resources. Due to the objection raised by local fishermen he finds it difficult to collect juveniles from brackishwater canals. Prawn seeds available from hatcheries are of the postlarval stage, usually, which require prestocking care in nursery confinements. Since Satyan does not have this facility he is not able to rely on hatchery supply.

NEWS—INDIA AND OVERSEAS

Welfare fund for fishermen proposed

The Ministry of Agriculture, Government of India plans to set up a National Welfare Fund for Fishermen and a National Fisheries Development Corporation during the financial year 1984–85. The fund will provide civic amenities like drinking water, medical and family welfare facilities, education and housing. There will be provision for educating children as well as active adults and for lean season relief and old age pension to fishermen after the age of 60. The NFDC will evaluate the viability of tuna fishing and will train Indian crew in the operation of sophisticated vessels and run the Minicoy Tuna Canning Factory at its full capacity.

Seafood News Letter 63 (5), 1984.

Record fish production in 1983 in Japan

Japan's 1983 fisheries harvest totalled 11.9 million tonnes which was an increase of almost 5 per cent over the 1982 catch. Of the total catch the contribution from the marine side was 11.7 million tonnes. Japan has successfully maintained its fisheries catch above 10 million tonnes since 1979 and continues to land the world's largest catch.

Marine Fisheries Review 46 (3) 1984.

The echosounder that sorts out fish

A new echosounder evolved by the SIMRAD can analyse echo returns and indicate the proportion of fish of various sizes in the form of bar-diagrams. The ES 380 colour sensitivity is said to be such that in some cases even species may be identified.

World Fishing, June, 1984.

Algae clean fish ponds

The U. S. Department of Agriculture working with Haifa Technion, has developed a method of using particular algae to clean fish culture ponds. It has been found that commercially raised fish grow faster and give higher yields in clear water. Electron microscopic studies revealed that certain unicellular algae used in the experiments, and normally found in the ponds, are encased in a gelatinous material. This enables the muddy particles to stick to the algae and to accrete in numbers until the whole conglomeration sinks. As a result, transparency of the ponds increased from about 2 cm to more than 30 cm in four weeks after treatment. It has been found that 4.5 to 9 kg of nitrogen and phosphorous fertilizer per acre encouraged growth of the algae.

World Fishing, March, 1984.

Krill harvest by Japan

Japan harvested 32,000 tonnes of Antarctic krill during the year 1983/84 season. Ten large trawlers engaged in this fishery landed 23,000 tonnes of raw frozen krill, 8,000 tonnes of boiled frozen krill and 1,000 tonnes of meal and other products. Another two trawlers engaged in the Japan–Chile joint venture caught 3,500 tonnes. The use of krill in food is increasing and 70 per cent of last year catch went for direct consumption.

Fishing News International, 24 (6), 1984.

Yacht paint toxins damage shell fish

Shell fish in estuary waters around Britain are under threat from the underside of yachts. Antifouling paints traditionally used on the hull of yachts are found to cause the death or deformity of significant numbers of shell fish. The paint which slowly releases toxins into the water inhibiting marine growth, contains tin based compounds which can in turn be deadly to many kinds of marine life and their larvae.

Marine Pollution Bulletin, May, 1984.

Compiled and prepared by Dr. M. J. George, Dr. K. J. Mathew, Mr. G. Nandakumar & Miss Jancy Jacob
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No. 60
NOVEMBER, DECEMBER
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Technical and Extension Series

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

COCHIN, INDIA

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the National Marine Living Resources Data Centre (NMLRDC) and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

Abbreviation – *Mar. Fish. Infor. Serv. T & E Ser.,* No. 60: 1984

CONTENTS

Cover photo: Purse seiner hauling up oil sardine off Cochin

THE INDIAN OIL SARDINE FISHERY: A REVIEW

V. Balan
Central Marine Fisheries Research Institute, Cochin

Introduction

The Indian oil sardine is one of the major marine resources of our country contributing about 15–25% of the total all-India marine catches. Hence, the role it plays in the economic life of the fishermen is significant. Since the beginning of this century, with the accumulation of valuable data, we have acquired a relatively wide spectrum of knowledge of this species, which will be of immense value in decision making for the rational exploitation of the resource. It may be recalled here that during the past several decades, this resource has been encountering wide fluctuations, both seasonal and annual which have been its characteristic feature.

During the present quinquennium there have been conspicuous changes in the fishing strategy for the major pelagic fishes such as the oil sardine and the mackerel, related to the advent of synthetic fibres for net making and the machanised purse seine crafts, as a result of which some of the traditional gears which were employed for successful fishing during the past several decades, have become rather obsolete. Although purse seine has extended the area of fishing operations, resulting in additional exploitation of oil sardine, mackerel and some other valuable pelagic resources such as the whitebaits, lesser sardines, horse mackerels, tunas, black pomfret, tachysurids, etc., during these years, its impact on the traditional fisheries is being felt to some extent in different areas.

Since the turn of the century, several investigators have studied the various biological aspects of the oil sardine fishery which have been well documented. The present review has been attempted with a view to highlight the trends in the production, research results and prospects relating to the oil sardine resource.

The sardine fishery and production

The traditional fishery of oil sardine has been found restricted to a narrow strip of 10–25 km of the coastal sea. Artisanal gears such as boat seines, shore seines, gill nets and cast nets have been employed for the fishery. But towards the close of the past decade purse seines have been introduced along the southwest coast for efficient exploitation of the resource.

Widely fluctuating trends have been observed in the landings of the oil sardine right from the early years for which catch statistics are available. The fishery was a failure during the years 1908–09 to 1911–12 and from 1914–15 to 1918–19. It was exceptionally good during 1922–23 and 1923–24 when the total production of its oil and guano along the west coast of India reached the colossal figures of 20,000 and 57,000 t respectively. Though above average during 1925–26, the fishery was poor in the subsequent seven years. Though revived during 1933–34, the catches declined remarkably during the next fifteen years (lowest being 8.8 t in 1946–47). Eventhough improved during 1950 and 1953–55 they were poor in 1951–52, 1956, 1958–59 and 1962–63. In 1957, the catch was exceptionally good. In 1960–61 the catches were rather good. The landings indicated a tremendous improvement during 1964–68 with an all-time bumper yield of 3.01 lakh tonnes in 1968. While the catch being very good during 1969–71, it was below average during 1972–74. In the ensuing five years, the catches were average but declined in 1980. During 1981 to 1983 they improved remarkably with the betterment of the stock abundance (Figs. 1 & 2).

It is a remarkable feature that Kerala being the largest oil sardine yielding state, its sardine landings in relation to the total marine catches (Fig. 4) to a great extent reflected a mirror image of the all-India oil sardine catch trend during the period from 1956 to 1983 as discernible from Table 1 and Fig. 2.

All-India percentages of indigenous oil sardine catches in the total catches during 1964–71 were markedly above average. They were below average during

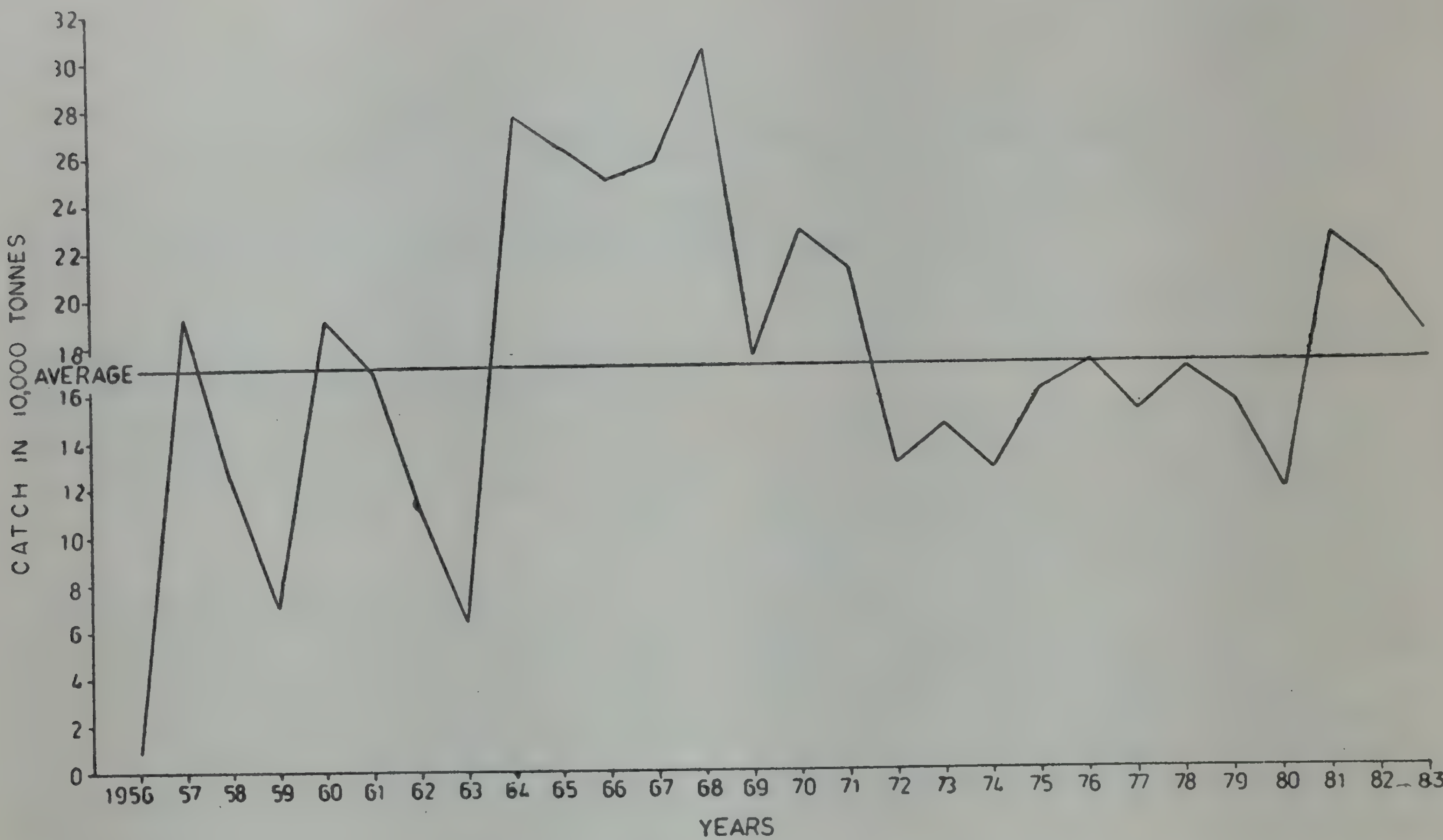


Fig. 1. All-India annual oil sardine landings.

1972–83; this striking decline in percentage composition may be attributed to increased landings of other fishes consequent on the proliferation of mechanised vessels all along the maritime states.

In Kerala also during 1964–71, percentages of oil sardine catches in the state's total all-fish catches manifested above the average trend (as that of All-India oil sardine catch trend). From 1972 to 80 and in 1983 the oil sardine catches recorded below average values; massive landings of other fishes by the intensified operations of trawlers would have effectively masked the oil sardine catches during that period. However, above average catches noticed during 1981 and '82 were mainly due to the increased landings by purse seiners. (Table 1 & Figs. 3 & 4).

Fishing areas: Large scale shoaling of oil sardine has been observed off the Kerala and Karnataka coasts. Within the Kerala zone, the area especially around the 11° N latitude accounts for the densest abundance. Normally, the fishing activity is found restricted to the region of about 3 to 20 km from the shore, and during the period of peak fishery, it may be even nearer to the shore. The usual depths at which shoals are encountered and captured range from 5 to 25 m.

Biology

Studies made earlier and the detailed investigations carried out recently have thrown light on various aspects of biology of the oil sardine such as the age and growth, length-weight relationships, meristic and racial aspects, reproduction, sex composition, maturation, fecundity, spawning, larval life, food and feeding, distribution, local movements and migration, shoaling and related behaviours, fisheries and the trends of fishery fluctuations etc.

Age and growth: Divergent views have been expressed by various investigators about its age, growth rate and life span on the basis of studies of age-marks found on scales, otoliths, opercula and length-frequency analysis of the fish. In general, it has been proved conclusively that the fish grows at a rapid rate during the first twelve months; and growth is at the highest during the intial two-three months of its life. The results obtained by various authors are enumerated in Table 2.

Table 1. *All-India and Kerala annual percentage composition of oil sardine catches among other fihses during 1956–82*

Years	ALL-INDIA Oil sardine catch (t)	Total landings of oil sardine & other fishes (t)	Percentage of oil sardine.	KERALA Total oil sardine (t)	Total fish landings including oil sardine (t)	Percentage of oil sardine
1956	7,412	7,18,779	1.03	5,065	1,52,213	3.33
1957	1,91,469	8,75,516	21.87	1,75,851	3,10,411	56.65
1958	1,23,731	7,55,994	16.37	1,18,971	2,95,135	40.31
1959	69,234	5,84,587	11.84	62,036	1,92,625	32.21
1960	1,89,016	8,79,681	21.49	1,86,219	3,46,684	53.71
1961	1,67,884	6,83,569	24.56	1,66,005	2,68,624	61.80
1962	1,10,299	6,44,244	17.12	91,203	1,92,470	47.39
1963	63,647	6,55,484	9.71	58,950	2,03,242	29.00
1964	2,74,333	8.59,582	31.91	1,90,401	3,17,973	59.88
1965	2,61,863	8,32,777	31.44	2,19,170	3,39,173	64.62
1966	2,47,214	8,90,311	27.77	2,02,800	3,46,744	58.49
1967	2,56,324	8,62,631	29.71	2,35,410	3,64,129	64.65
1968	3,01,446	9,02,948	33.38	2,47,048	3,45,301	71.55
1969	1,74,249	9,13,630	19.07	1,39,983	2,94,787	47.49
1970	2,26,997	10,85,607	20.91	1,91,683	3,92,880	48.79
1971	2,09,261	11,61,389	18.02	1,94,977	4,45,347	43.78
1972	1,27,568	9,80,049	13.02	1,04,426	2,95,618	35.32
1973	1,44,395	12,20,240	11.83	1,22,783	4,48,269	27.39
1974	1,26,676	12,17,797	10.40	1,02,135	4,20,257	24.30
1975	1,59,240	14,22,693	11.19	97,183	4,20,836	23.09
1976	1,69,262	13,52,855	12.51	1,23,937	3,31,047	37.44
1977	1,50,130	12,59,782	11.92	1,17,356	3,45,037	34.01
1978	1,68,078	14,03,607	11.97	1,19,937	3,73,339	32.13
1979	1,53,971	13,88,380	11.09	1,16,834	3,30,509	35.35
1980	1,15,744	12,49,837	9.26	69,667	2,79,543	24.92
1981	2,21,026	13,78,457	16.03	1,46,986	2,74,395	53.57
1982	2,05,294	14,20,624	14.45	1,43,215	3,25,795	43.96
1983*	1,83,706	15,44,389				
Average	1,70,410	10,40,909	16.47	1,39,468	3,22,791	43.21

* Figures provisional for 1983.

Apart from the length-frequency based studies on the fish, the problem of age and growth was studied in detail by scale method. And, on the basis of scalimetry, the time of ring-formation and the annual occurrence of each annulus or "ring" were found out and this knowledge was used as a tool for the determination of the age of the fish. Studies on the otoliths of the fish also have yielded some reliable clue to the problem of age determination. Majority of the investigators agree that the growth is very rapid during the first twelve months. Balan (1964) on the basis of detailed scale studies found that the fish attains an average length of 14.3 cm on completion of one year and 16.4 cm when it is 2 years and 18.4 cm when it is three years old.

Food and feeding: The fish is a plankton feeder. Among the phytoplankters, *Fragilaria oceanica, Pleurosigma, Coscinodiscus* and *Biddulphia* were dominant. Copepods, nauplii, cladocerans, larvae of bivalves and dinoflagellates preponderated among the zooplankters. Copepods formed the principal food of the juvenile fish. Intensity of feeding was found high during June-October coinciding with the rapid growth

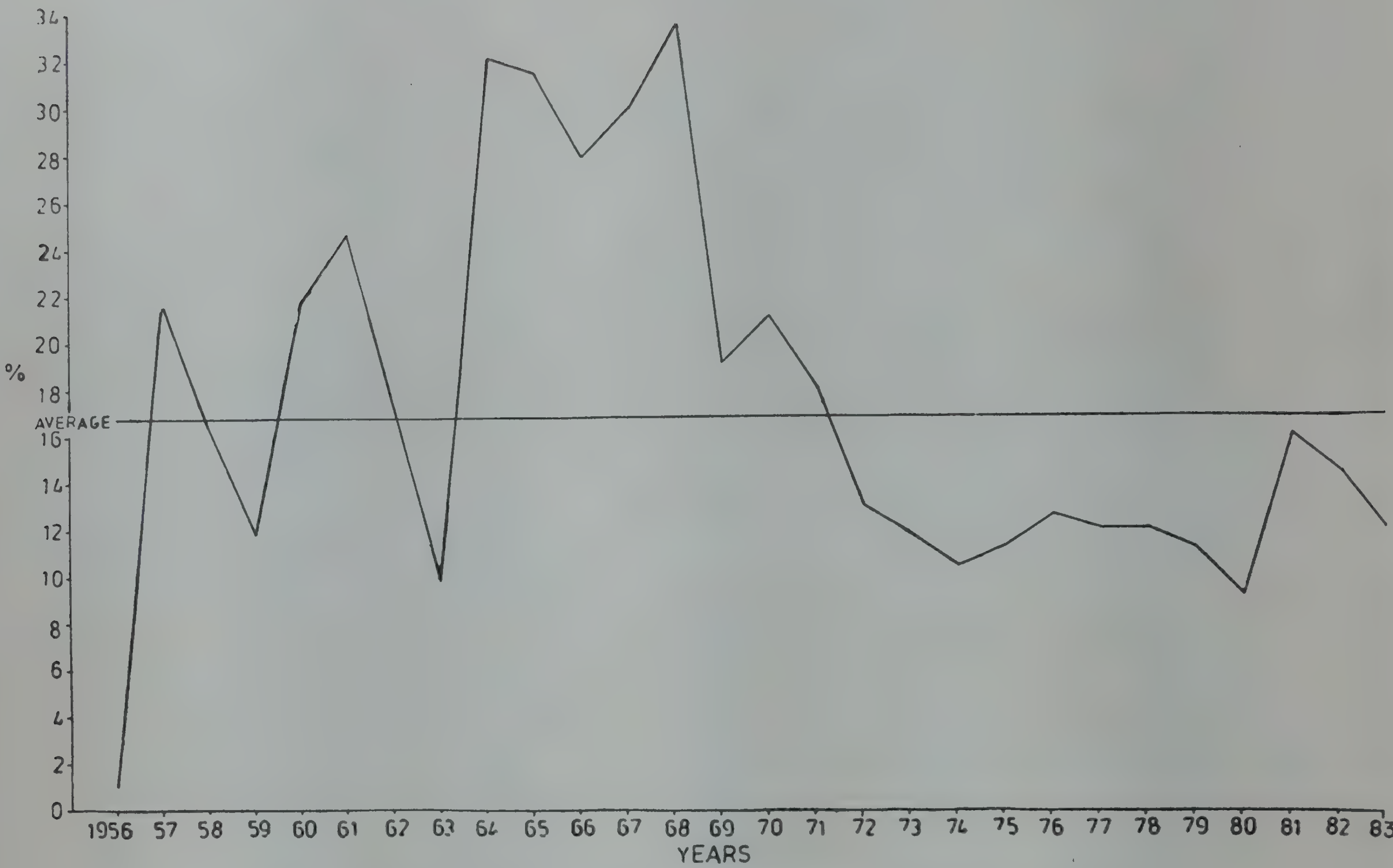


Fig. 2. Annual percentages of All-India oil sardine landings, among all other species.

Table 2. *Total lengths (in cm) of oil sardine at various ages, as observed by different authors*

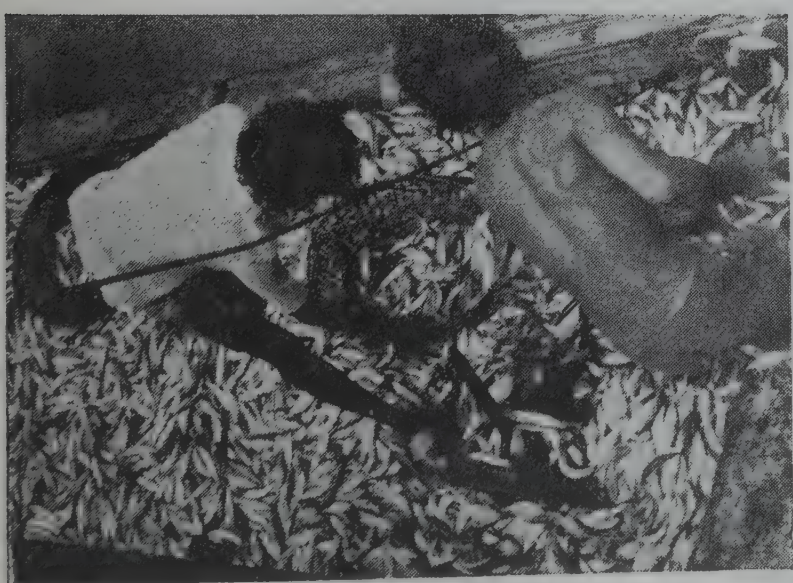
Authors	Years 1	2	3	4	Remarks
Hornell & Nayudu (1923)	15.0	16.0	—	—	Estimated 125 to 140 mm growth in 6 months. Suggested a life span of 2½ years.
Devanesan (1943)	6.5	—	—	—	Presumed a life span of 14 years when the fish are 18 cm in length.
Chidambaram (1950)	10.0	14.5	18.3	20.5	About 4 years life span.
Nair (1949, 1952 & 1960 a)	10.0	15.0	19.0	—	The fish 21 cm long being in the fourth year.
Balan (1964)	13.0	16.0	17.5	—	Based on average length frequency during 1955–64. The 17.5 cm long fish completed 3 years.
	14.3	16.4	18.4	—	Based on scale studies (by back-calculations).
Raja (1969)	15.0	17.8	—	—	They attain 60–95 mm, 95–110 mm, 110–125mm and 125–140 mm, at the end of one, two, three and six months. The mean length of 18.5 cm attanied on completion of 2½ years (length–frequency).
Sekharan (1965), Prabhu & Dhulkhed (1967), Sekharan & Dhulkhed (1967) and Bennet (1969)	—	—	—	—	They indicated that the juveniles measuring about 100 mm are one-year olds and those between 100 and 150 mm. length are in the second year.
Bensam (1968)	—	—	—	—	Juveniles register very rapid growth before they are 12 months old.

Oil sardine landings by the indigenous gear *(Thangu vala)* at Fisheries Harbour, Cochin.

A deck-full of oil sardine and other fishes aboard a purse seiner moored at the Fisheries Harbour, Cochin.

Auctioning of oil sardine catch from a carrier boat at Fisheries Harbour, Cochin.

Oil sardine strewn as 'waste' during glut at the Fisheries Harbour, Cochin.



Scooping oil sardine catch for unloading from a carrier boat at Fisheries Harbour, Cochin.

Oil sardine iced and packed in baskets ready for loading in lorry at Fisheries Harbour, Cochin.

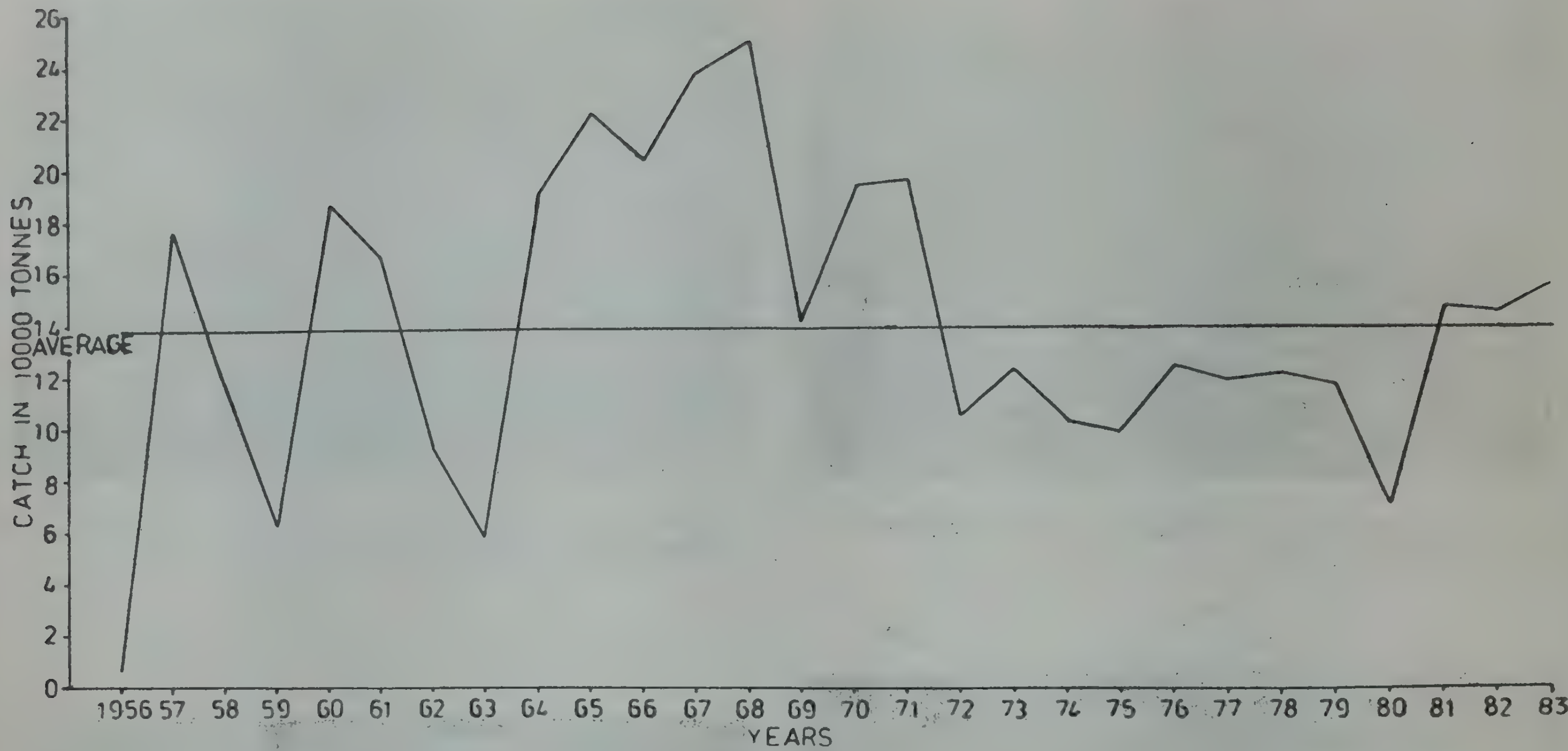


Fig. 3. Annual oil sardine landings in Kerala State.

rate during the period and it declined during November-March. During the period of spawning, starvation was invariably noticed among the adults (Nair, 1960 b).

Spawning: According to most of the investigators, eventhough the period of spawning extends from May to November, its peak is during June to August. Normally, the spawning was found to take place at about 15 km from the shore, in a depth range of about 30 m. In this regard the abundant occurrence of the gravid, the spent and the juvenile fish in the nearshore waters off Kerala and Karnataka states lends support to findings of the various authors. According to Raja (1971) a conspicuous incidence of follicular atresia of ovaries may cause a marked decrease in the egg stock. He attempted to correlate the atresia to low average daily rainfall during spawning nights and inferred that the average daily rainfall below 20 mm would result in a large-scale follicular breakdown and cause a decrease in the egg and larval production. But none of the later investigators has so far reported incidence of the atresia in the ovaries of the oil sardine.

Fecundity: The average fecundity (No. of ripe eggs) values, according to the different authors, range from 37,000 to 80,000. The body weight-fecundity and total length-fecundity regressions have already been studied (Balan, 1966). In view of the significant role the fecundity plays in the egg and larval production potentials and the subsequent recruitment of the juveniles into the fishery and the year to year changes in fecundities, a correct estimate of the same is essential.

Variations in sex ratio as observed by different authors are given in the attached Table 3. Post-spawning mortalities were also found affecting sex composition to some extent as reported by many investigators earlier. Differences in its ratio may be attributed to differential growth also, but need to be established.

Maturation: The fishery in the nearshore waters commences with the abundance of the maturing fish (IV & V stages), followed subsequently by the juveniles during August-September. Normally, occurrence of fish in stage VI in the commercial catches has been rather rare. After spawning during June and July, the partly-spent fish occur during August-September followed by the spent ones in October and the latter continues till December. After January, these fish from the spent-recovering stage II start developing progressively during February, March and April as stages III and IV. After maturing to stage V during May, the spawning act would get consummated any time with the onset of monsoon rains and conducive hydrobiological conditions. Juveniles from stage I during August-September pass on to stage II during October-December. Subsequently, like the once-spawned adults, the juveniles also pass on

to the III and IV stages during January to April and advance to the stage V in May to enter the active virgin spawning phase in June with the onset of monsoon rain. After completion of their spawning, they also pass on to the maturation stages similar to those of the once spawned fish.

Table 3. *Fecundity and sex ratio of oil sardine, quoted from different authors*

Authors	Fecundity	Sex ratio
Hornell & Nayudu (1923)	—	Dominance of females up to size at first maturity; reduced sexual segregation among ripe fish.
Devanesan (1943)	70,000–80,000	—
Devanesan & Chidambaram (1948)	70,000	Ratio equal below 20 cm length.
Chidambaram (1950)	—	Females dominated above 20 cm size; equal proportions of sexes up to 20 cm.
Nair & Chidambaram (1951)	75,000	—
Nair (1960)	78,000	Sex ratio almost equal among juveniles and spawners.
Balan (1966)	48,119 (average)	Females preponderated during 1959 to 1965 (excepting in 1963) in boat seine catches at Cochin.
Balan (1973)	—	No significant dominance of either sex in purse seine catches during 1969–1971 at Cochin.
Balan, *et al.*, (1979)	—	In 1978, females dominated at Calicut, Cochin and Karwar. Males dominated at Mangalore.
Raja (1969)	—	No seasonal differences in sex ratio; no sexual dominance among juveniles. Females were distinctly more among overall population of recovering spawners.
Raja (1971)	37,000–38,000 (average)	—

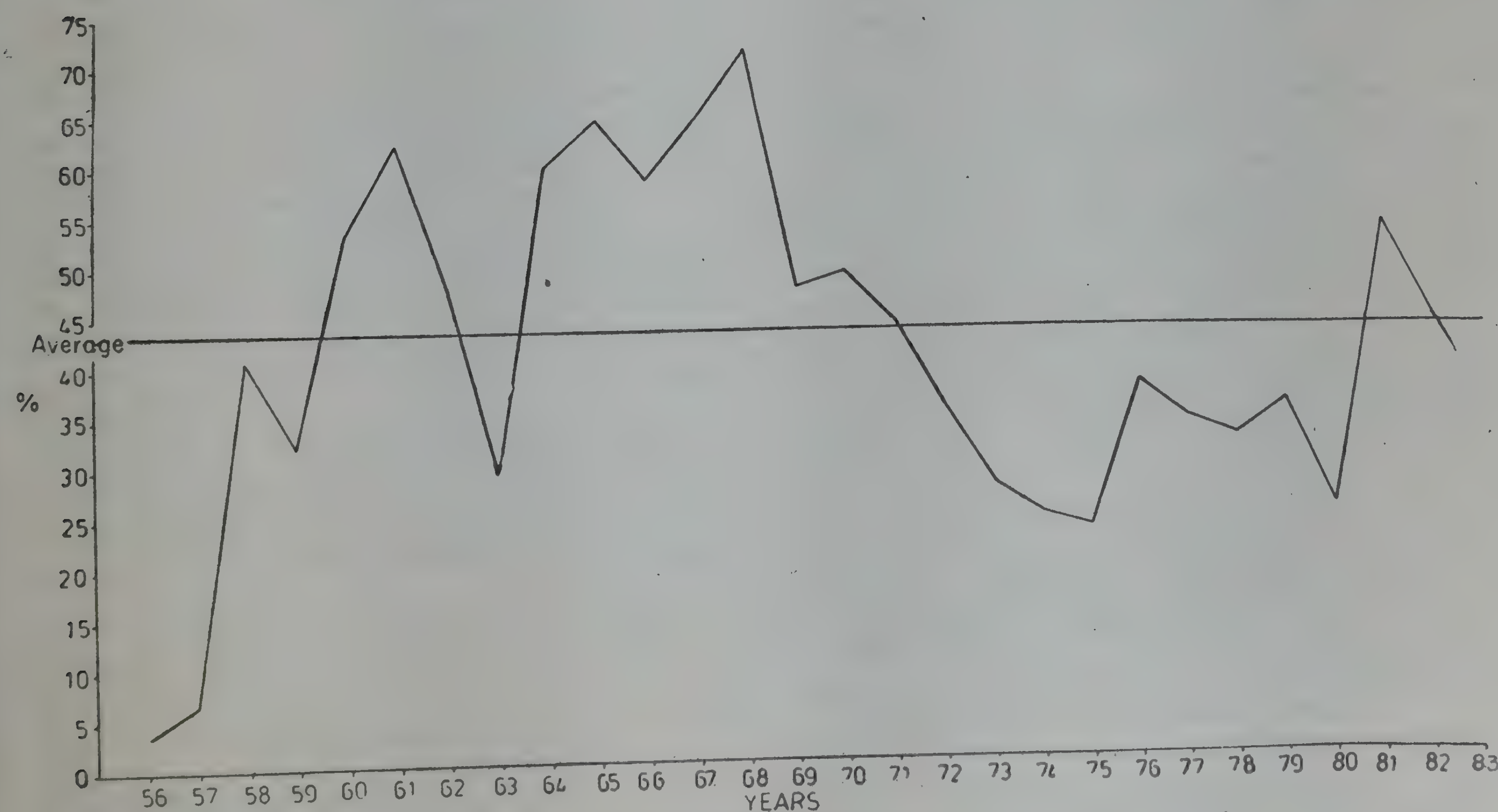


Fig. 4. Percentages of annual oil sardine landings among all other species, in Kerala.

Egg structure: The maximum and modal sizes of the intra-ovarian eggs were found to vary respectively between 1.20 to 1.23 and 0.97 mm. The transparent ripe intra-ovarian egg has a yellow oil globule (0.09–0.13 mm in diameter) which may be found occasionally broken up into 2 or 3. The planktonic eggs were found to range from 1.02 to 1.70 mm in diameter.

Its larval history was also studied by Nair (1960 a) though not comprehensively.

Shoal behaviour: Our present knowledge of this important aspect of biology of the fish is limited to what was observed by Balan (1961) wherein the various categories of the sardine shoals and their behaviour patterns or traits were indicated in detail. A clear knowledge of their behaviour and distribution in space and time based on echo-trace studies and shoal-scouting and mapping is an essential pre-requisite for the fish detection and for designing suitable fishing gears and effective fishing strategies.

Recruitment: As the fishery fluctuations are normally a manifestation of abundance of the 0-year and 1–year classes, the situations existing in the early recruitment phase may mainly influence the recruitment pattern in the exploited phase of the fishery each year. The fecundity potential, the success or failure of spawning, natality, survival of the spawn and larvae can also in their turn effect changes in the recruitment level.

The population abundance: According to the C.M.-F.R.I Annual Report (1968), the fishing mortality (F) was only 0.7, whereas the yield per recruit attains the maximum when it is double the present F. The total mortality "Z" has been reported varying between 0.09 and 1.88 in which the natural mortality was 0.26. No significant differences in growth parameters were noticed between the different fishing centres and a single equation can represent the data for the entire west coast which is: $L_\infty = 207$ mm., $k = 0.53$ on yearly basis and $t_0 = -1.33$ years.

Banerji (1973) estimated the total annual oil sardine stock in the fishing grounds as 4,40,000 t and the average standing crop as 2,10,000 t. The corresponding figures as estimated by Sekharan (1974) for the years 1960–71 were 8,10,000 and 3,90,000 t respectively. Balan *et al.* (1979) stated that the total stock level should be about four lakh tonnes based on the average annual crop and should be above two lakh tonnes based on the average of 10 years' (1969–78) oil sardine landings (1,31,440 t) in Kerala. It is also in agreement with the earlier (1972–76) estimates made by UNDP/FAO Pelagic Fisheries Project, Cochin.

Causes of the fishery fluctuations

Fluctuation in abundance of the resource of the oil sardine was ascribed to the success or failure of its spawning by Chidambaram (1950) and Raja (1969) while Hornell (1910) opined that it may be due to changes in diatom production or food availability to the fry and prevalence of favourable hydrological conditions. While "over fishing" that was deemed responsible according to Devanesan (1943) and heavy fishing of the immature fish and the periodic offshore migrations according to Sundara Raj (1934 & 1937) and Nair & Chidambaram (1951), it was due to the destructive fishing of the immature fish (Devanesan & Chidambaram, 1943). Abundant availability of *Fragilaria oceanica* was attributed as the principal causative factor for the sardine abundance according to Nair (1952) and Nair & Subrahmanyan (1955).

It appears reasonable to infer that since the fishery is supported largely by the 0-year group, the fluctuation in a season would be dependent on the rate of juvenile recruitment of the same season, i.e., on the strength of the juveniles resulting from major spawning of the same year, thus indicating that if spawning was not quite successful, it would be found reflected in the juvenile fishery of the same year and not after some years as Chidambaram (1950) suggested. Raja (1969) stated that greater incidence of "*Corpora atretica*" would cause reduction in the potential egg stock for release which he correlated to abnormally low average daily rainfall during spawning fortnights. Murty and Edelman (1970) stated that the intensity of monsoon, on the west coast of India over and above its critical value would be favourable not only for enrichment of sea by nutrients but also by dissolved oxygen.

Thus, an increase in the strength of the monsoon over its critical limit would be favourable for an increase in the sardine catch and below the critical value, the catches were found to decline.

The overfishing problem as suggested by some authors would mean that with an increase in the effort, there would be a decreasing catch per effort. Banerji (1973) found no relationship between the abundance and fishing effort and stated that the present level of fishing mortality is only half of that associated with maximum sustainable catch.

"Availability" changes also, being generally influenced by oceanographic and biological factors, have very often been found to play an important role in causing success or failure of the sardine fishery in the coastal waters since the operations of the fishing crafts are at present confined to the nearshore shallow areas.

In the light of the factors already enumerated, in general, the southwest monsoon and the resultant biological, oceanographic and meteorological conditions seem to be responsible for the catch fluctuations to a large extent. Nevertheless, with the existing knowledge, it is rather difficult to categorically establish any particular causative factor responsible for the yield fluctuations.

Prospects

On the basis of the data that are so far available, it can be reasonably inferred that the resource potential of oil sardine off our west coast is quite high despite its inherent seasonal fluctuations in abundance. Conservation of the resource and proper management of the fishery needs attention in view of its wide fluctuations coupled with the increasing intensity in fishing effort. Hence a few important aspects which should receive closer attention for a proper management approach in the fishery may be mentioned.

First of all identification of the nature of the population whether there are homogeneous populations or subpopulations or geographic variation, if any, in the different regions off the west coast needs consideration.

Difficulties have been experienced in aligning certain size groups or age groups occurring off Calicut and Mangalore with the pattern of maturation cycle and of growth obtained at other places such as Cochin, Karwar etc., indicating urgent necessity for taking up intensive studies on the population parameters at different centres of the fishery especially in view of their seasonal migrations.

The spawning survey of the sardine needs special attention since our present knowledge of the exact time, duration, area and depths of spawning (including the conducive environmental factors), distributions of the spawn, larvae and larval history are rather fragmentary.

It is imperative that detailed investigations have to be carried out on a continuing basis to understand the impact of intensive purse seining on the oil sardine catches of indigenous gears and on the consequent economic conditions of the fisherfolk of the Karnataka and Kerala States so that proper resource conservation measures, if found necessary, may be taken at the proper time. It may be recalled here that during the past five years, since the introduction of the purse seiners at Cochin, due to the unlawful fishing by purse seiners in the nearshore water where generally, the indigenous crafts operated has often given rise to frequent conflicts at sea. It is a matter of constant complaint by artisanal fishermen that their catches as well as prices realized from their poor catches go down miserably due to the indiscriminate and unrestricted operation of the purse seiners (Jacob *et al.* 1982). Regulatory measures restricting the depth zones for operation of the different gears together with the study of the resources position in the different areas in order to render proper advices to the fishing industry are quite essential.

The relationship of these fishes with the environmental parameters is quite well known. The recent (1982–83) large-scale wide-spread occurrence of catastrophic "El Nino" phenomenon in the major oceans, and the seas of the Asian continent manifesting with an abnormal increase in sea temperature and with concomitant changes in other hydrographic parameters, have probably markedly influenced the resource fluctuations of the oil sardine also. Thorough investigations on the resource in relation to these changes in environmental features have to be necessarily carried out on a continuing long term basis.

I am grateful to Dr. E. G. Silas, Director, for suggesting the preparation of this review and to Dr. M.J. George, Scientist S–3, for suggesting improvements in the manuscript and to Shri. K.V.N. Rao, Head, Pelagic Fisheries Division and to Dr. K. Alagaraja for the benefit of discussions I had with him during the preparation of the manuscript and to Shri M.A. Nizar, Technical Assistant, for his help in drawing the graphs.

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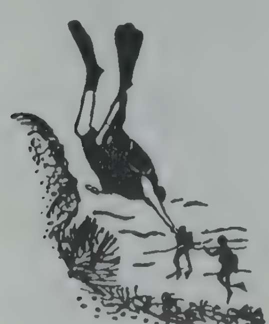


EXPORT ORIENTED PROCESSING OF INDIAN JELLY FISH *(MUTTAI CHORI,* TAMIL) BY INDONESIAN METHOD AT PONDICHERRY REGION*

Introduction

The jelly fishes which are being considered as a menace by the fishermen are gaining importance as a valuable food item of high protein content in the south-east Asian countries especially in Japan, Hong Kong, Korea and Indonesia.

The Indian jelly fish, popularly known in Tamil as *Muttai Chori* belongs to the phylum Coelenterata, sub-phylum Medusozoa, class Scyphozoa, order Rhizostomeae, family Rhizostomatidae and genus *Rhizostoma.* These are exclusively marine organisms in which the medusa is the dominant form. The body is umbrella shaped and almost transparent with slight green tint. These medusae which can attain a diameter of 80 cm have a firm bell or umbrella with a layer of dense mesogloea. Tentacles are absent but the mouth stalk has four lobes which divide to form eight thick gelatinous arms. As the medusa grows the arms fuse together and eventually close off the original mouth opening. This fulfil the role of tentacles as they carry nematocysts which are used for capturing food. The food is sucked in through many small openings, the suctorial mouths, which occur on the arms and is passed through a complicated canal system to the stomach cavity.

Availability of raw material in Pondicherry

The jelly fishes are commonly found in the inshore waters of Pondicherry and Tamil Nadu coasts. They are especially abundant during the months of January to June. The jelly fishes are brought towards the coast by the prevailing water currents. Fishing is done either by hand picking or by using scoop nets.

Processing techniques

Jelly fishes having a diameter of more than 25 cm are preferred for processing. Indonesian method of processing involves the displacement of body fluids of the animal by salt solution in a slow and long process.

The processing is carried out in seven stages for the umbrella and in six stages for the arm. In the case of umbrella the first five are the salting stages, the sixth is the salt drying stage and the seventh the packing and storing stage. For processing, the jelly fishes are to be treated within three hours of fishing, failing which the protein content of the gelatinous arms would be destroyed first followed by that of the body, resulting in very bad odour.

In the initial stage fresh jelly fishes are washed well in fresh water and then dissected into two halves; the upper (umbrella) and the lower (arm with stomach cavity). Later the unwanted stomach cavity is removed from the arms stalk. The separated portions of umbrella and arms are washed and put in separate tubs or tanks normally of the dimension of 2 m x 1.5 m x 1m. The tubs are made of casuarina poles and gunny bags lined with thick polythene sheets.

Processing for umbrellas

Stage 1: The umbrellas are kept for three to five hours or until the appearance of a thick white layer in the sub-umbrella part in a solution of the proportion of 100 1 of fresh water, 500 g of sodium alum and 200 g of bleaching powder. Afterwards the umbrellas are taken out and the white curdy substance is removed by

Rhizostoma sp. The Indian Jelly fish of export value.

*Prepared by L. Chidambaram, Field Centre of C.M.F.R.I., Pondicherry.

steel knives or thin bamboo blades without making any cut or scar on the umbrella. The thin membrane on the ex-umbrella side should also be removed carefully. The remaining solution is to be discarded.

Stage 2: The umbrellas thus cleaned are piled up one above the other in another tub with the sub-umbrella side facing up and kept for three to four days. For each layer chemicals in the proportion of sodium alum 1,200 g and sodium chloride 6,000 g are to be used. The solution remaining in the tub after processing can be reused.

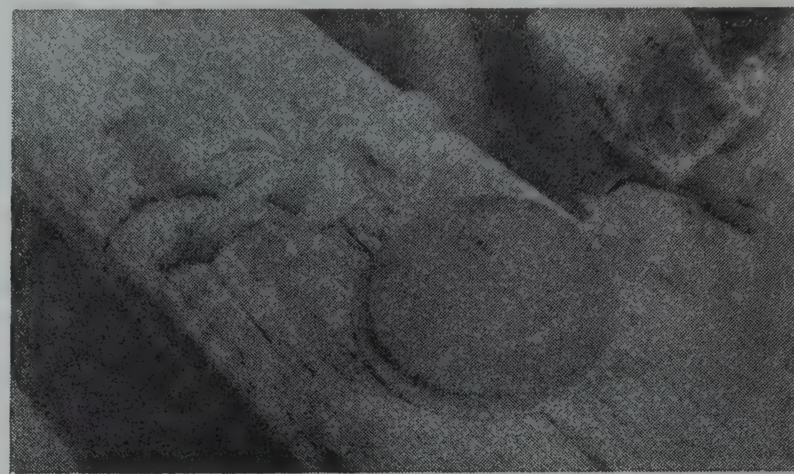
Stage 3: The body fluids get reduced by this process and after a reduction of 50% of the body fluids in the umbrellas they are transferred to a third tub and stored for three days with 600 g of sodium alum and 8,000 g of common salt.

A young fisherman boy brings the fresh Jelly fish for processing.

Stage 4: On reducing 70% of the body fluids in the umbrellas they are transferred into another tank and piled up adding half the quantity of sodium alum and full quantity of sodium chloride as was used in the previous stage. After four days of this treatment the umbrellas would have shrunken considerably with the edges folded. They are to be cleaned well with saturated solution of common salt of pH 4. The folded edges are to be straightened and the umbrellas are made flat again without any damage. Another tissue membrane now appeared on the concave part of the umbrella is also to be removed. The flattened umbrellas are again washed slightly in saturated salt solution of pH 4.

Stage 5: The washed umbrellas are layered in another tank and kept with 3,000 g of common salt. After three days, the treatment dealt under stage 4 is to be repeated.

Stage 6: In the sixth stage the cleaned and flattened umbrellas are layered in another tub upto the edge with 2,000 g of salt sprinkled over each layer. Saturated



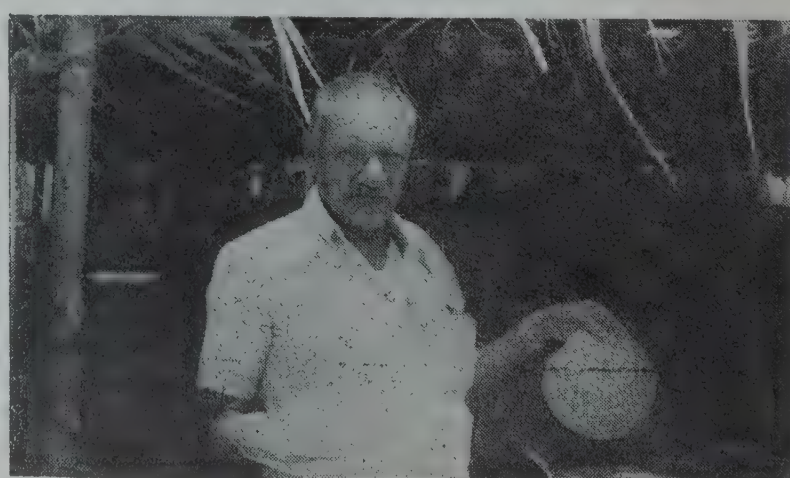
Beheaded Jelly fish: umbrella and arms.

salt solution of pH 4 is to be added to about 4/5 capacity of the tub. Then the top of the tub is to be covered with polythene sheet over which sufficient weight is to be placed for compressing purpose. In this way the remaining body fluid would also come out of the umbrellas.

Stage 7: The flattened umbrellas are piled up in a clean tub. Now the product is ready for packing, storing and exporting/marketing. The product can be packed after two days. The circular flattened umbrellas are piled up one above the other in polythene bags which are packed in wooden cases.

Processing for arms

In stage-1, 700 g of sodium alum and 4,000 g of common salt are dissolved in 400 l of water in a tank in which 15,000 arms could be placed. By giving extra pressure over the piled up arms the fatty substance and other impurities would come out. Afterwards the arms are washed in fresh water.



Final product: 'Chappathi' like umbrella.

In the second stage the arms are arranged in layers of 10 or 12 cm thickness and over each layer 2,500 g of sodium chloride and a little sodium alum should be spread. The arms are left for 24 hours in this condition after which they are thoroughly mixed in the same tank and left for three more days.

The third and fourth stages involve the same process and period as in the 2nd stage but in fresh tubs.

In stage-5 the arms are arranged in layers of 10 cm thickness with 1,600 g of common salt in between each layer. After piling up the arms in this way, saturated salt solution of pH 4 is to be added to the tub to make it 45 full and left for six days.

In the last stage the arms are transferred to another clean tank where they are kept for one day, after which packing could be done. The finished product of good quality should have elasticity and should weigh 70 to 78 g on the average.

Export: At present processed jelly fish are exported from pondicherry and South Arcot in Tamil Nadu only. In 1984, 21 tonnes of jelly fish products processed by adopting the Indonesian method have been exported from these areas by a private entrepreneur. The exports were made mainly to Japan, Thailand and Hongkong, the first named being the major importer.

I am very grateful to Dr. E. G. Silas, Director, C.M.F.R.I., Cochin-18 for his kind encouragements.

AN UNDESIRABLE METHOD OF FISHING USING POISONOUS AND TOXIC CHEMICALS*

Recently a novel method of fishing using poisonous and toxic chemicals by fishermen in some fish landing centres, north of Madras Harbour has come to notice. According to an eye witness account at Ondikuppam on 26-10-83, fishes were seen at a distance of less than a kilometer from the shore struggling in distress at the surface layers and fishermen were seen hand picking them from the area using catamarans. The fishes caught in this way belonged to the following genera 1) *Pristiphoma,* 2) *Therapon,* 3) *Lethrinus,* 4) *Otolithus,* 5) *Lutianus,* 6) *Polynemus,* 7) *Serranus* (8) *Diagramma,* 9) *Arius,* 10) *Mugil,* 11) *Gerres* and 12) *Portunus* (crab).

A survey made at the landing centres north of Madras Fisheries Harbour upto Ennore revealed that the local fishermen use some chemical for fishing in areas with rocky bottoms and boulders mostly during rough seas. It was observed that a waste product from some industry at Ambattur is being used for this type of fishing. This product which is a chemical complex mixture is put in a gunny bag and dipped to the bottom and taken up two or three times when the demersal fishes from the rocky areas would come up to the surface waters in distress and these are hand picked by the fishermen. This chemical mixture is obtained by some parties in drums and sold to fishermen at the rate of Rs. 10/- for a block of 500 gms.

On cursory examination of the chemical it was found that it was a white hard block with blackish dots interspersed over the surface. It was hygroscopic in nature and had a peculiar odour of cyanide. It was water soluble giving a soapy feeling indicating its alkaline nature.

The qualitative analysis done at A. C. College of Technology, Madras revealed the presence of cyanide and sodium ion, the latter being detected by the flame test. The quantitative analysis carried out at the Chemicals Testing and Analytical Laboratory, Government of Tamil Nadu, Guindy, Madras revealed that the chemical sample was a composite chemical mixture and contained 3.82% of cyanide, 0.83% of lead and 0.53% of chloride. Further comprehensive quantitative estimations are being conducted by this laboratory to understand its full composition. Since the chemical

*Prepared by D. S. Rao and K. G. Girijavallabhan, Madras Research Centre of C.M.F.R.I., Madras.

contains cyanide and lead there is no doubt that the chemical complex material is a health hazard not only to the local fishermen but also to those consumers who use the fish for food.

The pathogenetic effects found in suicide cases using potassium cyanide are well known. It includes apopletic and epileptic symptoms and the very pronounced symptom is slow breathing. Loss of consciousness and vision are reported to have occurred by cyanide poisoning. In most cases agonising attacks of neuralgic pains between temporal regions and ciliary arch and maxilla, with screaming and apparent loss of sensitivity as if struck with apoplexy, with face flushed have been reported.

Among the best known symptoms of poisoning by lead in humans are the colic and drop-wrist. In addition, there are conditions of kidney irritation with albuminuria, ending in granular degeneration with attendant heart hypertropy, optic neuritis and blindness. There is an excess of uric acid in the blood of persons under the influence of lead and actual gouty deposits and gouty attacks are observed. Chronic enlargement of the knees and contraction of the lower limbs with complete crippling are also observed in some cases. Lead also causes small aneurisms almost all over the body. In those who have drunk the lead contaminated water, effects vary in intensity according to the amount of contamination and duration of exposure. When the poisoning has been going on insidiously for years, a state of anaemia is set up with dry, inactive scaly skin and inveterate composition.

These investigations reveal that more and more fishermen resort to toxic and poisonous agents to narcotise the fish in their environments and catch them since it is an easy way without involving expenditure or much fishing effort. It seems that this method of fishing is mostly resorted to get big demersal fishes which will fetch higher price. The fishes caught by this way are coming to the markets in the nearby areas. The consumer who buys this fish is not aware because he cannot distinguish the differences between the fish caught by conventional and the present method.

Further work on the action on the toxic effect of the complex chemical mixture on the common food fishes are in progress. Bio-assays to find out the toxic effects as well as LC 50 and LT 50 and also the effect on the environment are being carried out.

This method of fishing using cyanide and lead containing products will pose a health problem even to those fishermen in the long run by their constant handling of these chemicals. They are exposed to the danger of getting into their system minute quantities of cyanide and lead which may ruin their health. As such this type of fishing should be totally banned forthwith by a suitable legislation by the authorities concerned.

OCCURRENCE OF POST-LARVAE OF *PENAEUS CANALICULATUS* OLIVIER AND JUVENILES OF *P. JAPONICUS* BATE AROUND KARWAR*

Regular samplings are being made as part of the programme for the assessment of seeds of prawns, and their seasonal abundance in the creeks of Palollem and Muduga and also in the estuaries of Kali, Belikeri and Gangavali (Fig. 1). In all these places the common species of penaeid prawns viz., *Penaeus indicus, P. merguiensis, P. monodon* and *Metapenaeus dobsoni* occur showing seasonal fluctuations in their abundance. However, during September, 1982 for the first time on this part of west coast, the presence of a few post-larvae of

*Prepared by G. Nandakumar, Karwar Research Centre of C.M.F.R.I., Karwar.

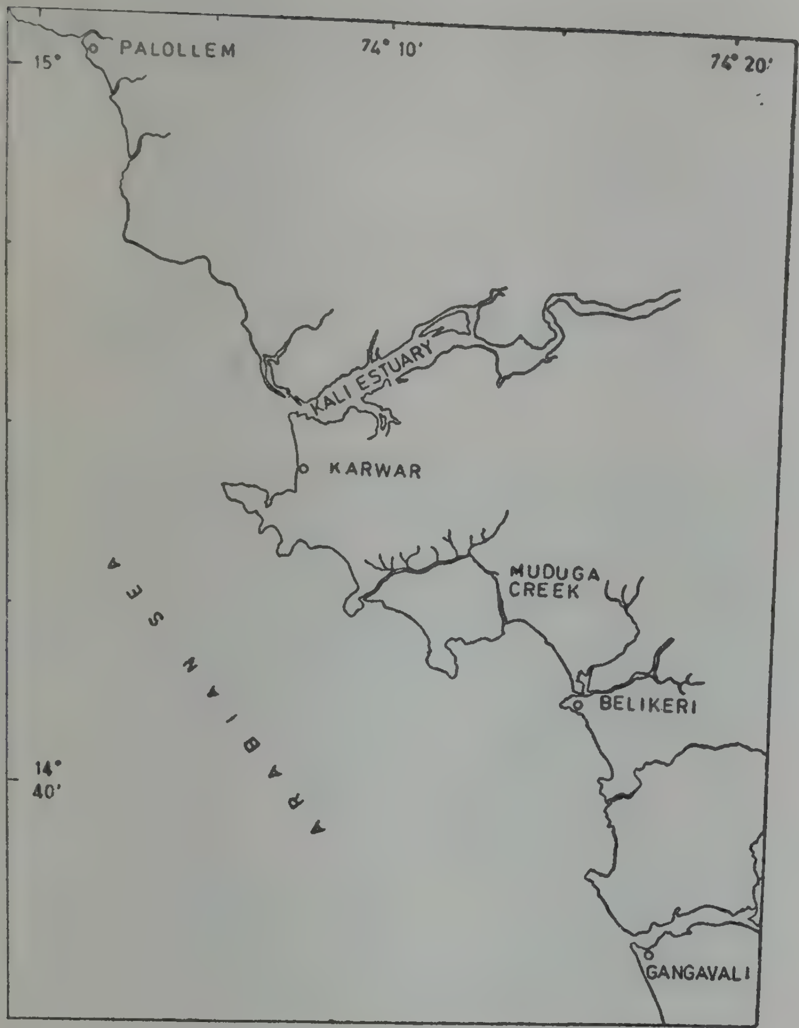


Fig. 1. Prawn seed sampling centres in Uttar Kannada District.

P. canaliculatus was noticed in collections made by velon netting in the Palollem and Muduga creeks. Subsequently, a few numbers of them were observed in April, 1983 in the estuary of Gangavali and again in June at the former place. The post-larvae measured in total length from 9 mm to 11 mm and their density varied from 3 to 165 numbers/100 m^2 area.

Another interesting observation on the occurrence of juveniles of *P. japonicus* of size range 20–50 mm, (3–47 numbers/100 m^2) was made during October '83 for the first time in the estuaries of Kali, Belikeri and Gangavali. In the subsequent two months, they were observed in the Gangavali estuary only.

The occurrence of post-larvae of *P. canaliculatus* and juveniles of *P. japonicus* indicates that they have an extended distribution on the west coast and it appears that their spawning grounds may not be far off from the places indicated above. As these two species are fast growing, it is felt that vast stretches of low-lying estuarine and backwater areas in the Uttar Kannada district of Karnataka, could be utilised for their culture.

THE BRAMBLE SHARK *ECHINORHINUS BRUCUS* (BONNATERRE) LANDED AT COCHIN*

Two female sharks having the diagnostic characters of *Echinorhinus brucus* (Bonnaterre) were caught by hooks and line fishermen southwest of Cochin about 60 km from the shore from depths of 120–160 metres on 9 February 1984 (Figs. 1 & 2). The specimens weighing about 100 kg, were auctioned for Rs. 500/- and were immediately taken to Kuravilangad, an interior market 60 km from Cochin, along with about 350 kg of *Eulamia melanoptera* and 30 kg of *Zygaena tudes* which were together auctioned for Rs. 2,700/-. Since this deep water shark *(Echinorhinus brucus)* is of very rare occurrence and has so far not been reported from commercial fish landings, a brief description of the species is given below.

*Prepared by K. V. Somasekharan Nair and K. Thulasidas, C.M.F.R.I., Cochin.

Table 1. *The body measurement of* Echinorhinus brucus (*Bonnaterre*) *(in mm) landed at Cochin Fisheries Harbour*

	Specimen-1		Specimen-2	
	mm	Percentage proportion in total length	mm	percentage Proportion in total length
Total length	2,280	—	1,970	—
Weight (kg)	60	—	40	—
Trunk: at origin of pectoral (depth)	510	22.3	335	17.0
at origin of 1st dorsal	440	19.3	286	14.4
Snout: length in front of mouth	245	10.7	202	10.3
in front of eye	220	9.6	181	9.2
Eye: vertical diameter	35	1.5	30	1.5
interorbital distance	269	11.5	225	11.4
Mouth: width	260	11.4	216	11.2
Distance from snout to: 1st dorsal	1,500	65.7	1,390	70.5
2nd dorsal	1615	70.8	1,500	79.1
pectoral	700	30.7	610	30.9
pelvic	1,480	65.9	1,248	63.3
genital opening	1,690	74.1	1,430	72.5
1st gill opening	465	20.3	430	21.8
First dorsal fin: vertical height	180	7.8	175	8.8
length of base	155	6.8	105	5.3
Second dorsal fin: vertical height	150	6.5	136	6.8
length of base	115	5.0	100	5.0
Caudal fin–upper lobe: vertical height	285	12.5	230	11.6
length of base	448	19.6	350	18.0
Pectoral fin: vertical height	290	12.7	260	13.1
length of base	190	8.3	140	7.1
Pelvic fin: vertical height	260	11.4	195	9.9
length of base	300	13.1	260	13.2
Interspace between 1st and 2nd dorsal	115	5.0	116	5.8
Distance from origin to origin of pectoral and pelvic fins	610	26.7	550	27.9
second dorsal and caudal fin	110	4.8	115	5.8

The colour of the specimens was pale dark dorsally and pale white ventrally. The body was covered with numerous whitish tuberculated scales; each scale with a basal shield of varying size and a sharp pointed spine, which is characteristic of the species. However, some of the spines were blunt. The lateral line ran along the upper half of the body commencing from the first gill opening to the tip of the upper caudal lobe. The body measurements of the specimens in mm along with the proportional dimensions in percentage of total length are given in Table 1.

The bramble shark *Echinorhinus brucus* (Bonnaterre) usually occurs in the upper conitnental slope and the deeper neritic waters of the Atlantic, Mediterranean and Indo-Pacific. The presence of the bramble shark along the continental slope of the west coast of India was first brought to light by Silas *(Bull. cent. mar. Fish. Res. Inst.*, 12, 1969) during the exploratory fishing cruises of R. V. *Varuna*. Subsequently Silas *et al.* (*Curr. Sci.,* **38** (5), 1969), Nair and Lal Mohan *(Indian J. Anim. Sci.,* **41** (10), 1971) and Silas and Selvaraj *(J. mar. biol. Ass. India.,* **14** (1), 1972) have reported the

Fig. 1. Dorsal view of the bramble shark *Echinorhinus brucus* (Bonnaterre) landed at Fisheries Harbour, Cochin.

occurrence of the species along the continental slope of the southwest coast of India and Gulf of Mannar from depths of 215 to 405 metres during the cruises of R. V. *Varuna,* M. V. *Blue Fin,* M. V. *Velameen* and M. V. *Klaus Sunnana.*

These deep water sharks were caught when the artisanal fishermen from Colachel were fishing with hooks and line in the hitherto underexploited fishing grounds in deeper waters. The hooks and line fishery is conducted at slightly shallower fishing grounds (40-70 m) for mainly sharks and at deeper waters (80–160 m) for 'kalava.'

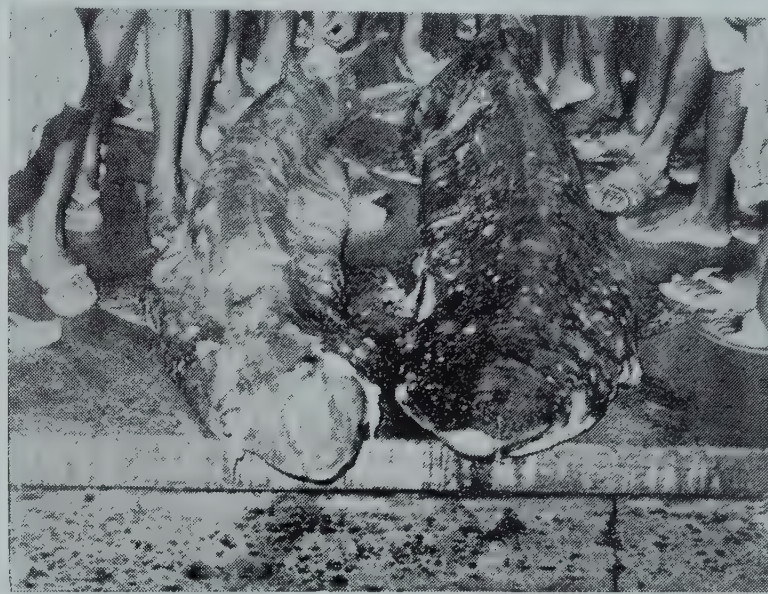


Fig. 2. Anterior view of the bramble shark *Echinorhinus brucus* (Bonnaterre) landed at Fisheries Harbour, Cochin.

At present about 8 units are operated from Cochin Fisheries Harbour.

The authors are thankful to Dr. E. G. Silas, Director, for constant encouragement and to Shri K. V. Narayana Rao, Head, Pelagic Fishery Division for guidance.

Compiled and prepared by Dr. M. J. George, Dr. K. J. Mathew, Mr. G. Nandakumar & Miss Jancy Jacob
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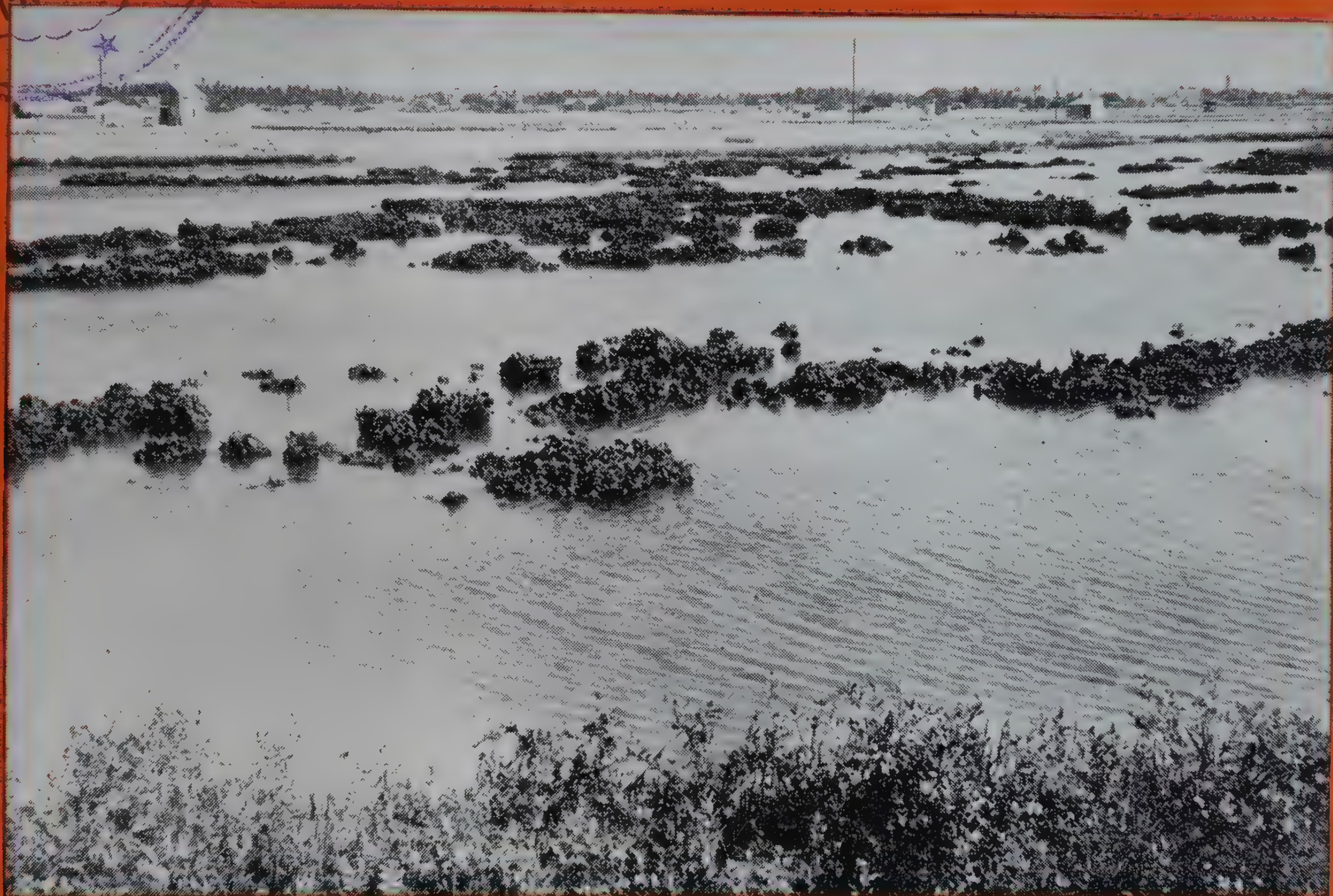

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THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the National Marine Living Resources Data Centre (NMLRDC) and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

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CONTENTS

Cover photo : A view of the natural edible oyster bed exposed during low tide at Tuticorin

MOLLUSCAN FISHERIES OF INDIA

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Tuticorin Research Centre of C.M.F.R.I., Tuticorin

Introduction

Molluscs form valuable fisheries in various parts of the coasts of India providing shellfish as food and as source of lime, pearls and decorative shells, as constituents of medicinal preparations etc. The commercially important molluscs of the country consist of oysters, mussels, clams, ark shells, pearl oysters and other bivalve molluscs, the sacred chank *(Xancus pyrum)*, *Trochus niloticus*, *Turbo marmoratus* and some other gastropods and cephalopods including squids, cuttlefishes and octopods. The available resources are exploited at numerous places all along the coasts of the country using a variety of fishing methods but the total production is not high compared to several other countries of the world. However, in recent years following an increase in the fishing effort and greater awareness of the resources, there has been a steady rise in molluscan production. The Central Marine Fisheries Research Institute has recognized the importance of molluscs as valuable fishery resource and conducted several studies on the identity, distribution and biological characteristics of the resources and the trends in production of some of the major species. Very recently researches have been carried out on the culture of oysters, mussels, and clams as well as pearl culture, and culture methods have been developed which would be useful in adopting mariculture practices. In this article, the present status of exploitation of molluscan resources in the country and the progress made in researches on the culture of bivalve molluscs are presented and the possibilities for better utilization of the resources by proper exploitation are emphasized.

Molluscan Resources and Fisheries

Oysters

Oysters are one of the most valuable among molluscs found along Indian coasts and are widely distributed in estuaries, creeks, backwaters, bays and harbours wherever rocky or other hard substratum is found. Several species of oysters have been reported from India of which four viz., *Crassostrea madrasensis*, *C. gryphoides*, *C. discoidea* and *Saccostrea cucullata* form beds and are of economic importance (Nayar, 1980). *C. madrasensis* has extensive distribution, occurring in Sonapur backwaters in Orissa, Pulicat Lake, Ennore, Killai backwaters, Karangad, Athankarai, Pinnakayal and Tuticorin (Fig. 1) on the east coast and in Vembanad Lake, Cochin, Beypore and Tellicherry in Kerala and

Fig. 1. Natural oyster bed of *Crassostrea madrasensis* at Tuticorin.

several estuaries of Karnataka on the southwest coast. The oysters at Sonapur are fished regularly for converting the shells into poultry feed (Alagarswami and Narasimham, 1973). Small sized oysters from Pulicat Lake were previously grown to marketable size in the shallow parts of the Lake and sold to meet the requirements of a few hotels in Madras city. Now oysters are occasionally collected from natural beds and supplied when there is demand. Along Cochin coast and in Mulki, Udayavara, Coondapur and villages bordering Kali river, oysters are collected for domestic consumption or sold at Rs. 3–4/- per 100 nos. thus forming a sustenance fishery. Oysters are collected by dislodging them with a strong knife or a chisel. The shells of this species are also used in the manufacture of calcium carbide.

In *Crassostrea madrasensis* of Adyar estuary a main spawning season extending from October to December and usually a second season from March–April have been observed (Rao, 1951). *C. madrasensis* spawns twice in a year during April–May and August–September at Tuticorin and grows to a size of 90 mm at the end of one year when meat forms 8–10% of total weight (Mahadevan, Nayar and Muthiah, 1980). *C. gryphoides* occurs along the Maharashtra and Goa coasts and is fished in fair quantities at a number of places such as Bombay, Alibag, Ratnagiri, Malvan, Ratnagiri Ribander, Siolim and Curca. *C. gryphoides* spawns between July and September in Kelwa waters and grows to a maximum size of only 48 mm at the end of one year (Durve and Bal, 1962). In the creeks of Gulf of Kutch, Port Okha, Dwarka and Porbunder in Gujarat the disc oyster *Crassostrea discoidea* occurring in muddy bottom is fished for its meat. In Poshetra *Crassostrea cristagalli* is exploited for meat but this species is a small sized one and fetches a price of Rs. 3/- per 100 nos. *Saccostrea cucullata* commonly known as the rock oyster due to its occurrence on rocky substratum is found on both east and west coasts but is more common on the west coast. This species grows well in marine environment and fisherfolk collect it from sandstone or granite boulders in the intertidal zone.

Mussels

Mussels are an important molluscan fishery resource in India. These are found in the coastal waters on rocky substratum up to a depth of 10 m and are fished at low tides using a knife. Of the two species (the green mussel *Perna viridis* and the brown mussel *Perna indica)*, the green mussel occurs at a number of places on Indian coasts and forms thick beds at Quilon, Alleppey, Cochin, Malabar coast, Karwar, Goa, Malvan, Ratnagiri and in Gulf of Kutch. In these areas the green mussels are regularly exploited for the meat which is relished very much. The green mussel resources are particularly abundant on the rocky coasts from Calicut to Tellicherry where there is an active fishery. On the east coast small beds of green mussels occur only at a few places viz., Visakhapatnam, Kakinada and Madras. *Perna viridis* attains a length of 92 mm at the end of one year at Kakinada and its breeding period is prolonged extending from December to July (Narasimham, 1980a). Unlike the green mussel, the brown mussel *Perna indica* has a limited distribution from Varkalai near Quilon on southwest coast to Cape Comorin with good fisheries at Varkalai, Kovalam, Vizhinjam, Poovar, Muttom and Colachel. The brown mussel grows to a size of 35–36 mm in a year on Vizhinjam coast and breeds from May to September (Appukuttan and Nair, 1980).

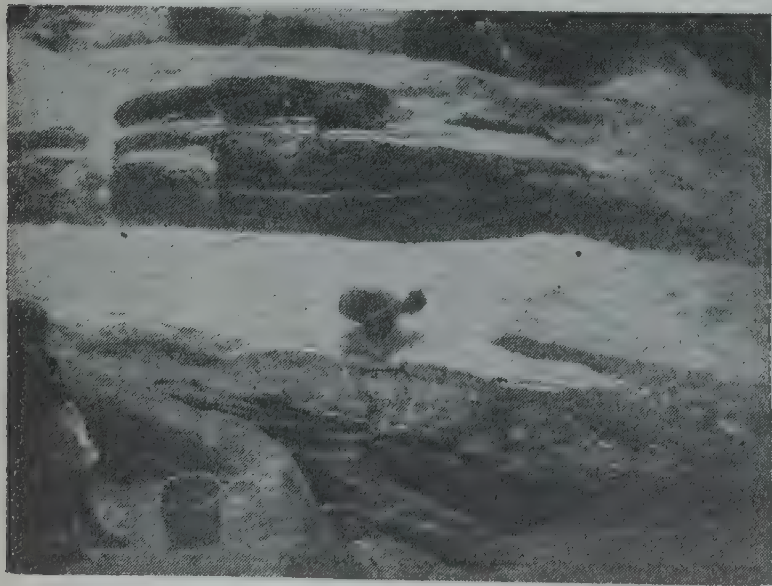

Fig. 2. Fishing of the brown mussel *Perna indica* on Vizhinjam coast.

Clams

In terms of total production, clams are the foremost among the molluscan resources in India. They are distributed along both coasts but the resources along the west coast are very considerable as compared to those on the east coast. Clam fishing is generally done by hand picking or with scoop nets. In several estuaries of Maharashtra, Goa, Karnataka and Kerala on the west coast there are regular fisheries for different species of clams. *Meretrix casta, Katelysia opima* and *Paphia laterisulca* are the species caught from the estuaries and backwaters in Maharashtra. Two species of clams *M. meretrix* and *Villorita cyprinoides* support clam fisheries at Tiracol, Chapora, Sal, Mandovi, and Zuari estuaries in Goa (Alagarswami and Narasimham, 1973).

In Kali river in Utthara Kannada district, Karnataka there is a very good clam fishery of *Meretrix meretrix, Paphia malabarica* and *V. cyprinoides*; the annual clam production amounting to about 2,000 t (Nayar *et al.*, MS). Clam fishing is carried out in Kali river by hand picking or with a net which has a semi-circular mouth and is operated with leg. In the estuaries of Dakshina Kannada district, in contrast to Utthara Kannada district, *Meretrix casta* is generally the dominant clam species, the other species occurring in commercial catches including *M. meretrix, Paphia malabarica, V. cyprinoides* and *K. opima*. An estimated clam production of 79 to 128 t including mostly *Villorita cyprinoides* are fished annually from Netharavathi estuary at Mangalore (Rao, K. S., MS).

In Kali river and Coondapur estuary vast subfossil clam shell deposits are present and these are exploited on a large scale using dredges. The fishermen who fish live clams in the Kali river vehemently oppose the exploitation of shell deposits using the dredging equipment and they contend that along with shells live clams present in the area are caught in large quantities and destroyed.

There are extensive sub-fossil molluscan shell deposits largely comprising of clams in Vembanad Lake, the total resource of which has been estimated as 2–4 million tonnes. The annual estimated production of shells from the lake is 1,98,809 t of which live clams form 26,859 t (Rasalam and Sebastian, 1976). Fishing is carried out using a long handled spade as in the southern portions or with a drag net. Mechanical suction type dredgers are used by M/s. Travancore Cements Ltd. and Travancore Electro-Chemical Industries Ltd., which exploit large quantities of lime shells for the manufacture of cement and calcium carbide. Lime shells are used for a number of other purposes like preparing of morter and slaked lime, for neutralising acidic soil and in rayon and paper industries. Large quantities of sub-soil lime shell deposits occur in Kodungallore and Ashtamudi lakes, and Kadalundi and Korapuzha estuaries also in Kerala. *Villorita* spp. form 90% of clam resources of Vembanad Lake and their meat is sold and consumed in a large number of surrounding villages. There is a good fishery for *Katelysia opima* in Ashtamudi lake for exporting clam meat.

On the east coast in Bahundi river in Orissa live *Meretrix* sp. occur along with oysters and subfossil shell deposits are quarried annually. From Chilka Lake good quantities of shells of *Meretrix* spp. are mined every year (Alagarswami and Narasimham, 1973). *Meretrix meretrix* is common in Kakinada Bay and about 400 t of the clams are landed annually. On the southeast coast, beds of *Meretrix casta* occur in Vellar and Vaigai estuaries. The clam beds in Vellar estuary support a fairly good fishery with yearly production of about 210 t (Natarajan *et al.*, 1979). *M. casta* is found in Chilka and Pulicat lakes and Vaigai estuary. There is a regular fishery for live *M. casta* in Pulicat lake. *Katelysia opima* occurs only sporadically in the lake. Good quantities of subfossil molluscan deposits are present in the northern part of Pulicat lake which are regularly exploited (Thangavelu, personal communication). Large subfossil molluscan deposits of *M. casta* and some other species have been located recently in Vaigai estuary at Athankarai and they are being actively exploited since 1978 (Nayar *et al.*, MS).

Ark shells

In Kakinada Bay the ark shell *Anadara granosa* is abundant and supports a fishery (Fig. 3), the annual production amounting to 130 t. The ark shells fished from the bay are mostly used in the production of lime

Fig. 3. Fisherwomen engaged in fishing *Anadara granosa* in Kakinada bay.

and only small quantities are utilized as food or for export. There is much demand in Japan for this species. An economic method of culturing this species has been developed by CMFR Institute (Narasimham, 1980b). Efforts are necessary to culture the shellfish and export them *A. granosa* occurs in Vellar estuary and Venkatpur estuary also but only in small quantities.

Window-pane oysters

These bivalves belonging to the species *Placenta placenta* the shells of which are used for glazing windows and are also sources of shell lime and pearls used in medicine, enjoy wide distribution in Indian seas occurring in Gulf of Kutch, Bombay, Malabar coast, Tuticorin, Mandapam, Nagapattinam, Madras and Kakinada Bay. Of the several places, only in Kakinada Bay and Gulf of Kutch window-pane oysters form a resource. The total biomass of this shellfish in Kakinada Bay has been estimated to be 8,945 t, the dead oyster resources forming another 43,348 t and the annual landing is 400 t (Murthy, Narasimham and Venugopalam, 1979) indicating that production could be increased several times. Till recently window-pane oysters were only converted into lime or pearls present were collected and used in preparing medicine. At present the right valves of the oysters are exported to Hong Kong, Japan

and Korea. In addition the shell valves with iridescent lustre are used in the production of chandeliers. The meat of window pane oysters is edible. Therefore the possibilities of popularizing it as food in the country have to be explored.

Pearl oysters

In India there is a continous demand for pearls for use in the making of jewellery, which is largely met through import of cultured pearls from Japan, the pearl production from pearl oyster resources in the country being erratic. Most beautiful natural pearls have been collected from pearl oysters of the species *Pinctada fucata* collected in pearl fisheries off Tuticorin coast in Gulf of Mannar and to some extent from Gulf of Kutch since very early times. The pearl banks in the Gulf of Mannar are under the control of the Government of Tamil Nadu which conducts pearl fisheries (Fig. 4) when the pearl banks known as *Paars* are populated by pearl oysters in abundance. In the present century only fourteen pearl fisheries have been conducted the last being as far back as in 1961. Pearl oysters occur in Gulf of Kutch and support small fisheries, the annual production amounting to 30,000 to 77,000 pearl oysters (Mahadevan and Nayar, 1973). Settlement of *P. fucata* has been noticed in Vizhinjam coast recently. *Pinctada margaritifera* which also yields pearls of high quality occurs only sporadically in India.

Fig. 4. Pearl oyster fishing boats being towed by mechanised vessel.

The pearl oyster production in the various pearl fisheries varies very much due to wide fluctuations in the stocks of pearl oysters in the pearl banks. Natural populations of pearl oysters are influenced by a variety of factors like recruitment, presence of *Modiolus* as a pest, occurrence of predators like sea stars, sharks, rays and skates, strong currents, drifting sand and unauthorised fishing.

Maximum of 21.4 million pearl oysters which brought a revenue of Rs. 4,51,098/- to the State Government were obtained in 1958 pearl fisheries. The maximum income of Rs. 8,00,568/- was achieved in the fishery held in 1959 when 16.4 millions of oysters were fished. In the 1961 fishery the total harvest of pearl oysters fished was 15.4 millions which fetched an income of Rs. 2,88,860/-. Observations made recently on the pearl banks in the Gulf of Mannar have revealed the presence of pearl oysters in good numbers in some of the paars. The Central Marine Fisheries Research Institute has achieved a major breakthrough by producing spherical cultured pearls in the pearl oyster *Pinctada fucata* (Alagarswami and Qasim, 1974).

Other Bivalves

There are also other bivalve molluscs of economic value like the razor shells *Solen* spp. in Ratnagiri coast (Rao *et al.,* 1962) and surf clams *Donax cuneatus, D. faba,* and *D. incarnatus* in various parts in the intertidal zone which are fished for their meat (Nayar, 1955, Alagarswami, 1966, Nayar and Mahadevan, 1974). *D. cuneatus* attains a size of 13–14 mm in one year and its spawning season extends from January to April in Palk Bay (Nayar, 1955). *D. faba* of Gulf of Mannar grows to sizes of 20 mm and 24 mm at the end of one year and two years respectively and spawns from November to June (Alagarswami, 1966). Other species like *Mesodesma glabratum* in sandy beaches, *Gafrarium* spp. in muddy habitat in Gulf of Mannar and the fan shells *Pinna bicolor* and *Atrina (Servatrina) pectinata pectinata* (Rao and Dorairaj, 1974) occurring in coastal waters of Mandapam area are bivalves which could be exploited.

Sacred chank

The sacred chank *Xancus pyrum* which occupies an important place in the lives of Hindus, being used in worship and in the manufacture of bangles worn by ladies in Bengal is distributed in the coastal waters of Tamil Nadu, Kerala and Gulf of Kutch in Gujarat. The major portion of the resources are distributed in Tamil Nadu where chanks occur in Tirunelveli, Kanyakumari, Ramanathapuram, Pudukottai, Thanjavur, South Arcot and Chingleput coasts. Chanks occur from shallow parts to depths of 20 m (Nayar and Mahadevan, 1973).

About 90% of the chank production is obtained by diving (Fig. 5) and the rest in nets or by fishermen wading in shallow waters. In Tamil Nadu chank

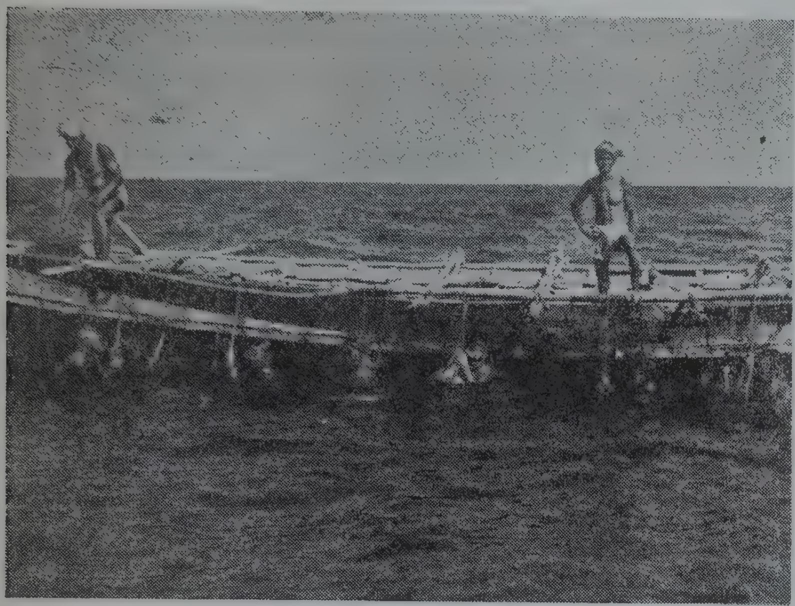

Fig. 5. Chank fishing by divers off Tuticorin coast.

fishing is controlled by the State Government which permits fishing by issuing licences to fishermen. Fishing of chanks below the size of 57 mm is prohibited, the under-size ones being returned to the sea. The chank production is highest in Tirunelveli area off Tuticorin coast. The fishing season extends in the area from November to May and over 900 divers are engaged in the fishery. During 1972–78 the number of full size chanks fished per season off Turicorin coast varied between 18,768 and 5,58,996. In the recent years 1978–83 the chank landings per season along the coast have been much higher ranging between 7,78,132 and 10,54,940 with maximum number of chanks having been obtained in 1982–83 season (Table 1). Next in importance is the

Table 1. *Number of full size chanks fished off Tuticorin coast during* 1972–83

Season	Number of chanks fished
1972–73	3,72,106
1973–74	3,58,883
1974–75	5,58,996
1975–76	12,365
1976–77	18,768
1977–78	19,171
1978–79	9,55,893
1979–80	8,01,035
1980–81	7,78,132
1981–82	7,95,645
1982–83	10,54,940

Source: Department of Fisheries, Govt. of Tamilnadu.

Kannirajapuram–Ramanathapuram fishery with a yearly production of 3,00,000 chanks.

Another 40,000 chanks are fished along the coasts of Tanjavur, South Arcot and Chingleput districts. Chank production is much less in other areas being 17,000 chanks caught in trawl nets off Quilon coast and 6,000 obtained in hooks and lines off Vizhinjam. From the Gulf of Kutch, about 12,000 chanks are fished annually. A number of varieties of chanks are recognised based on shell characteristics, the main ones being the beautiful spindle shaped *acuta* and the squat form *obtusa*. The sacred chanks with sinistral shells known as *Valampuri* (Fig. 6) which are greatly esteemed are caught in very stray numbers and these fetch a price of Rs. 10,000/- or more depending on the size and quality of the shell. The sinistral chanks are auctioned by the Government of Tamil Nadu.

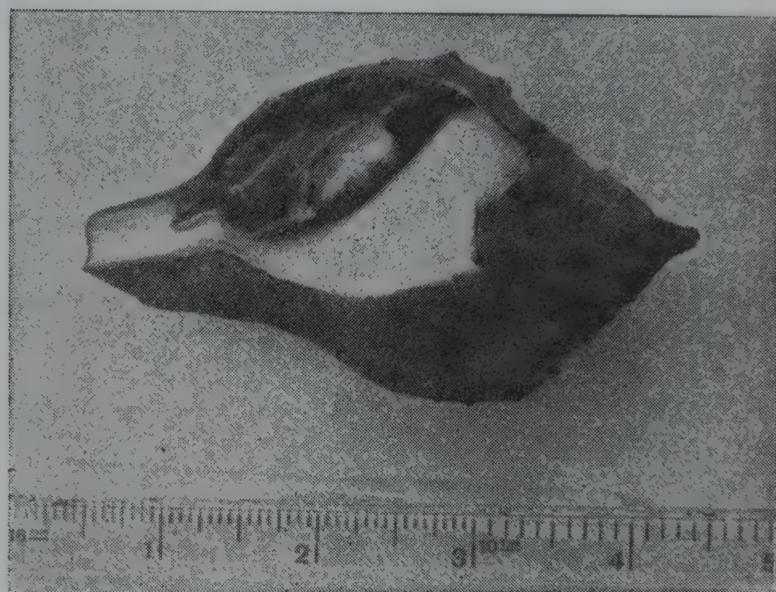

Fig. 6. A sinistral chank *Xancus pyrum*.

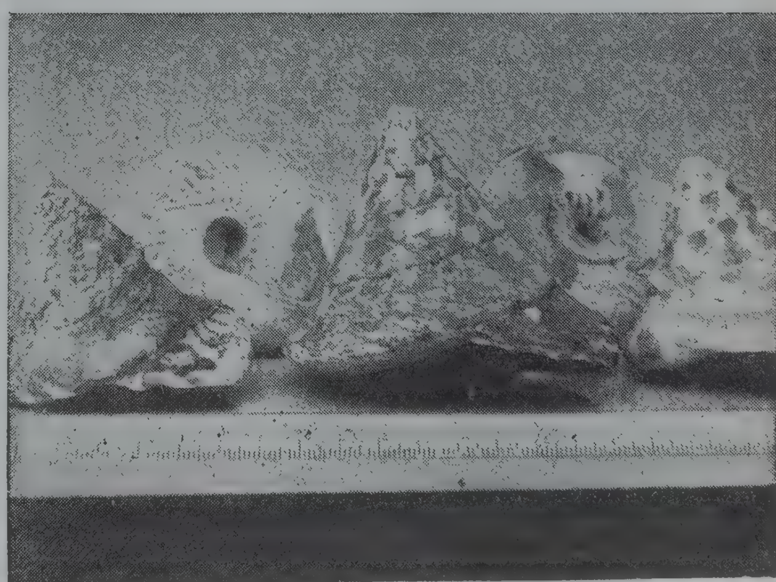

Fig. 7. *Trochus niloticus*.

Trochus and Turbo

Trochus niloticus and *Turbo marmoratus* (Figs. 7 & 8) form important local fisheries in Andaman and Nicobar

Fig. 8. *Turbo marmoratus.*

Islands, the annual production of the former amounting to 400-600 t and that of the latter 100-500 t (Appukuttan, 1977). In recent years a decrease in the catches of *T. marmoratus* is evident. There is very good demand for the beautiful shells of the two species with opalescent lustre, as a variety of utilitarian articles are made with them. The foot of the species is boiled, dried and consumed.

Other gastropods

Apart from the above species, there are other gastropods like *Turbo intercostalis, Oliva* sp., *Lambis lambis* and *Babylonia spirata* which occur in intertidal zone and littoral waters and could be utilized as food. Shells of *Tonna* spp., *Hemifusus* sp, *Cymbium melo, Umbonium vestiarium* and *Cyprea tigris* are collected and sold as such or made into handicraft articles. The cowries *Cypraea moneta* gathered from shallow coastal waters are used as dice. The early development of a number of prosobranch molluscs of Mandapam area has been studied by Natarajan (1957). Studies have been taken up by CMFR Institute at Mandapam camp to make some of the gastropods of economic importance breed in laboratory.

Cephalopods

In India squids and cuttlefishes are mostly obtained as by-catch in trawl nets, shore sienes, boat seines, hooks and lines and stake nets operated for fish and prawns, trawl nets accounting for 59% of total cephalopod production. The country's cephalopod production was meagre till 1973 after which there has been a remarkable increase in the landings to meet the demand for exports (Silas *et al,* 1982). In recent years, the annual cephalopod production varied between 9,548 t (1981) and 15,931 t (1978) (Silas *et al,* 1982, FRAD, CMFRI, 1982). 41.94% of the total landings are caught on the west coast and the rest on the east coast. Kerala, Maharashtra and Gujarat are the states with high cephalopod production, the three states accounting together for 79% of the production during 1978–81 while Tamil Nadu ranks fourth in importance. The commercially imporatnt species of cephalopods of India are the squids *Loligo duvaucelii, Sepioteuthis lessoniana, Doryteuthis* sp., *Loliolus investigatoris* and the cuttlefishes *Sepia pharaonis, S aculeata, S. breviamana, S. elliptica, S. prashadi* and *S. inermis.* There is an important local fishery for the squid *Sepioteuthis lessoniana* in Ramanathapuram district on southeast coast of India, which is exploited with a special type of shore seine *ola valai* (Rao, 1954). Octopods occur in sheltered crevices amidst rocks and coral stones at a number of places on the mainland and Lakshadweep and Andaman Islands. In Lakshadweep Islands they are fished by spearing, the annual production amounting to 13–20 t. A number of species of oceanic squids are known to be distributed in Indian ocean (Flippova, 1968) but their catch potential is to be assessed. Silas (1969) has pointed out that the oceanic squid *Symplectoteuthis oulaniensis* is common at high depths beyond 180 m off southwest coast of India. By carrying out exploratory fishing extensively on the continental shelf and oceanic parts and use of special gear like jigs, there is much scope for considerably increasing the country's cephalopod production. Squids and cuttlefishes are being exported in good quantities annually to several countries. The total cephalopod exports from India amounted to 3,028 t worth Rs. 75 millions in 1981.

General Considerations

Molluscan resources exist at innumerable places along the coasts of India and are exploited in varying degree of intensity forming valuable fisheries. The fisheries and biological aspects of the major species of molluscs of economic importance have been studied only at a few areas in the last few years. It is quite essential that these studies are intensified and extended to other areas which will help in taking steps to develop the fisheries. A big lacuna in the study of molluscan fisheries in India is the lack of detailed data on the production of the shellfishes such as oysters, clams, mussels, ark shells etc. At present such data is available only for pearl oysters, chanks and cephalopods. The

CMFR Institute has drawn up a programme to monitor the landings of the different groups of molluscs other than cephalopods. When this programme is implemented, we will have a clear idea of the status of the various molluscan fisheries of the country.

In the case of bivalve and gastropod resources, systematic resources surveys have to be conducted along the east and west coasts as well as the Andaman and Lakshadweep islands for assessing the standing stocks. A beginning has been made in this field and CMFRI has surveyed the molluscan resources of a number of estuaries and other brackish water systems in Kerala and Karnataka.

Bivalve molluscs such as oysters, mussels, clams, cockles and scallops are cultivated in shallow coastal waters on scientific lines in several advanced as well as developing countries of the world such as U.K., U.S.A., Canada, France, Spain, Holland, Germany, Australia, Japan, Philippines, Korea, and Taiwan to supplement production from exploitation of natural stocks. But unfortunately until recently no serious attempt has been made to adopt culture practices for bivalve molluscs in our country. In India where malnutrition is widespread, aquaculture of oysters, mussels, and clams can very much augment production from fishing natural beds and provide protein-rich sea food. Silas (1980) has stressed the importance of culture of edible molluscs as the production of biomass is high. The Central Marine Fisheries Research Institute has developed economic methods of oyster culture (Nayar and Mahadevan, 1980), mussel culture (Kuriakose, 1980) pearl culture (Alagarswami, 1980) and culture of *Anadara granosa* (Narasimham, 1980b). The culture of the bivalves could be carried out profitably in suitable littoral areas with the available technology as the materials required could be easily procured and farming conducted. During the last few years a very good demand has developed for the export of bivalve molluscs especially clams. Clams like *Katelysia opima, Meretrix* and *Villorita* have been collected from Ashtamudi and Vembanad lakes and over 510 t of clam meat worth Rs. 97,37,000 exported in 1982–83. Thus by improving the fishing methods and proper exploitation of the available molluscan resources it is possible for India to increase production substantially from the present level which will provide greater quantities of wholesome sea-food to meet internal demand and requirements of export industry. Besides the meat, the molluscan shells which are used in various ways bring substantial additional income.

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AN INSTANCE OF MASS MORTALITY IN THE MUTTUKADU FARM NEAR MADRAS DURING APRIL 1983*

Introduction

The Mariculture Centre at Muttukadu is situated in the Kovalam backwater and is about 36 km south of Madras City. The northern wing of backwater which ends abruptly near Karikattukuppam village has an area of 93 ha running parallel to the coast and is being converted into a fin fish and prawn culture farm (Fig.1). An earthern bund with steel sluice gates runs across the backwater separating the farm area from the main body of backwater.

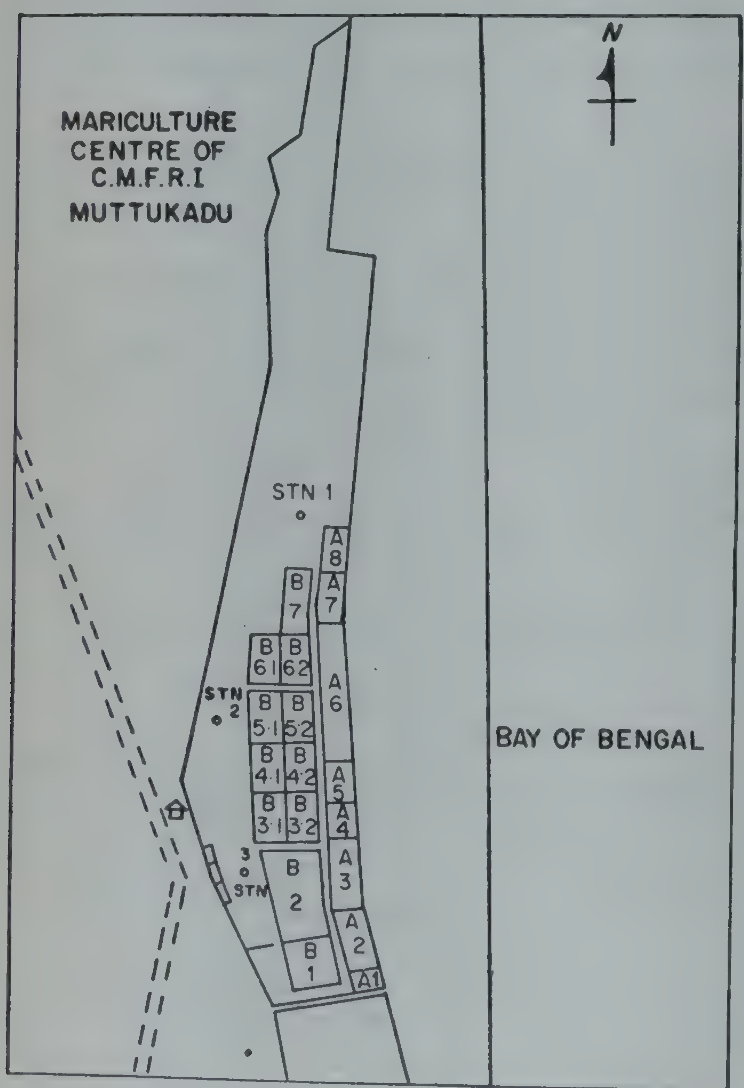

Fig. 1. Muttukadu fish farm.

*Prepared by M. Rajagopalan, K. G. Girijavallabhan, Geeta Bharathan, M. Kathirvel, P. Nammalwar and T. Dhandapani. *Madras Research Centre of C.M.F.R.I., Madras.*

The Kovalam backwater is connected to the sea only during part of the year, the bar mouth usually remains open in October/November. Free water exchange is thus rather limited. This is particularly true of the farm area; as such it is a separate wing of the backwater and the sluice gates further limit water exchange. This pattern of periods of no exchange alternating with periods of limited exchange is repeated every year. Over the past one year due to drought conditions even this limited water movement has been considerably curtailed. There had been very little rain during the monsoon of 1982, it not having rained after November, 1982. The bar mouth closed, by early January, 1983, much earlier than normal. Thus a closed system with no water exchange has been existing in the farm area.

During the period after July, 1981, construction of ponds and their deepening have been carried out on a large scale. A sizeable quantity of water was drained from the farm area for deepening and constructing new ponds in June, 1982 and January, 1983. The total body of water in the farm thus decreased considerably. Mariculture activities in the farm have been intensified particularly after October, 1982. All these activities have been changing the environmental conditions in the farm and adjacent waters. Regular environmental monitoring of these waters has been going on since July, 1981.

While carrying out routine environmental monitoring of the farm site, an unusual mortality of fishes and other organisms was observed in the open site surrounding the farm at Mariculture Centre of CMFRI, Muttukadu between 10–4–'83 to 22–4–'83 (Figs 2–4). The phenomenon was particularly extensive on 19–4–'83. The following is a brief account of this unfortunate incident, giving an analysis of the relevant parameters and discussing the probable causes.

Fish mortality

A few eels of the species *Thyrsoidea macrura,* cat fishes *Tachysurus jella* and *Plotossus anguilaris* were found dead and washed ashore in the early morning

Fig. 2. Dead fishes strewn over the farm edges — a general view.

Fig. 3. The dead fishes included several varieties.

Fig. 4. Another view of the dead fishes.

hours at the northern sector of the farm area on 10 and 11–4–'83 and again from 14 to 18–4–'83. On the 18th and 19th the mortality was particularly heavy and along the western side of the farm area dead cat fishes, eels, *Etroplus surratensis, E. maculatus, Scatophagus argus, Pomodasys* sp. were noticed near the edge of the water. On 20th also heavy mortality of nearly 200 eels and other fishes was noticed. On the same day in the morning *Chanos* and mullets were observed coming to surface gasping for breath in B2 pond. The details of dead fishes together with size range are given in Table 1.

Table 1. *List of dead fishes observed during the mortality*

Species	Size range (mm)
Liza macrolepis	150–342
Mugil parsia	299–315
Valamugil seheli	301–399
Chanos chanos	238–392
Etroplus maculatus	42–62
	(9 fish per m²)
Etroplus suratensis	144–178
Plotosus angularis	241–771
Tachysurus jella	100–484
Scatophagus argus	170–244
Therapon jarbua	38–148
Pomadasys sp.	306–394
Gobius sp.	39–52
	(467 fish per m²)
Cynolgossus cynolgossus	90–210
Thyrsoidea macrura	350–1840
Epinephelus aereolatus	160–630

Mortality of prawns

On 19th afternoon, while examining the pen in which a brood stock of *P. monodon* (200 mm) was being maintained, it was found that all the prawns were dead. From the condition of dead specimens, they appeared to have died during the early hours of 19–4–'83. A total of 73 numbers were found dead in the brood-stock pen.

Observation on the bloom

High density of phytoplankton was noticed in the first week of April '84 which later developed into a dense bloom of *Peridinium* sp. and *Ceratium furca.*

The bloom, colouring the water yellow-brown, extended throughout the farm in the open area as well as in the pond B2. Ponds A2 and A3 were predominated by *Oscillatoria.* The densities are indicated by Chlorophyll 'a' value (Table 3). The phytoplankton of the Kovalam backwater area analysed at the same time also contained the Dinophytes but in much smaller density. Continuous bright sunshine, high salinity and low level of nutrients favoured the growth of Dinophytes. Coinciding with the mass mortality of fishes on 19–4–'83 the bloom died out in the area around station 2 continuous with Pond B2. Plankton on that day contained no live *Peridinium,* very few *Ceratium* some *Navicula* and *Nitzschia* sp. and resting spores of *Peridinium.* A similar condition prevailed in Pond B2, the bloom, however, continued near Station 1 and in the canal between A & B Pond series. Thus there was a heterogeneity in the plankton composition and distribution.

The degeneration of phytoplankton extended throughout the farm area by the 23rd. On 24th the water was deep brown in colour and on examination proved to contain a bloom of *Thalassiosira* and *Synechocystis.* Subsequent detailed examination on 26–4–'83 again revealed a difference between the northern body of the farm area and the southern part. The former was found to contain mostly *Ceratium* with a few *Navicula* and *Nitzschia.* The southern part (Station 2) contained dense populations of *Chaetoceros* with numerous *Ceratium* too. Thus it appears that the bloom of *Peridinium* died successively, first in the area near the ponds, then in the ponds and then in the northern end. The bulk of the *Peridinium* appears to have formed resting spores which may again germinate and develop into bloom.

Zooplankton collections made on 12 and 19–4–'83 (night collection) and 26–4–'83 did not reveal any appreciable zooplankton populations. Only amphipods were noticed in the collections. Huge dead masses of amphipods were washed ashore on 19th morning to the extent that they formed thick beds at the water edge on the western side.

Environmental parameters

Chlorophyll: Chlorophyll 'a' values reflected the phytoplankton populations, being very high in the first fortnight, falling during the period of mass mortality and rising again in the reviving period; plankton population consisted mainly of diatoms (Tables 3& 4).

Gross productivity: From an average gross productivity of 200.11 mg C/m^3/day in January, the productivity rose to 2210.46 mg C/m^3/day in March and remained high during April (Tables 3 and 4).

Nutrients: During the peak of the bloom on 12–4–'83, of the nutrients studied only phosphate-P and nitrite-N were detected in low concentrations both in the open areas and in the ponds. One week later, at the time of mass mortality, phosphate-P showed a slight increase while nitrite-N remained at the same level. Ammonia-N concentration, however, increased tremendously, from nil to 28/ug–at/l (Table 3). These altered conditions led to bloom predominated by daitoms and the nutrients levels dropped significantly.

Temperature: General level of temperature was high, varying between 31.1 to 34.0 °C in the open area. In the ponds temperature varied from 31.5 to 36.0°C.

Salinity: The prevailing high temperature and lack of rain fall since December 1982 led to hypersaline conditions. This ranged from 45.1 to 48.8 ppt in the open area and 48.8 to 54.0 ppt in the ponds.

Table 2. *Environmental parameters: Estimated values as observed during the period of mortality*

	Atmosphere Temp (°C)			Water			Water transparency (cm)			pH			Salinity (ppt)			Dissolved oxygen (ml/1)		
Date	13/4	19/4	26/4	13/4	19/4	26/4	13/4	19/4	26/4	13/4	19/4	26/4	13/4	19/4	26/4	13/4	19/4	26/4
Stn. 1	29.5	28.8	29.2	31.1	33.8	32.4	56	54	78	8.1	7.8	8.4	45.1	48.8	43.9	4.08	0.65	3.76
Stn. 2	29.8	29.0	29.2	32.0	34.0	32.6	32	28	28	8.2	8.0	8.7	46.0	45.0	44 5	4.45	0.40	6.36
Pond A2	29.8	28.0	29.4	32.5	36.0	32.5	15	14	23	8.3	8.0	8.3	48.8	49.2	51.1	5.29	3.76	4.55
Pond B2	30.0	30.2	29.4	31.5	35.2	33.0	22	28	26	8.2	8.0	7.9	51.3	54.0	55.0	3.48	2.16	3.16

Dissolved oxygen: From the normal levels (3.58 to 5.29 ml/l) during the first fortnight, the dissolved oxygen concentration fell drastically (0.40 to 3.76 ml/l) on 19–4–'83 (Table 2). This may be the result of accumulated effect of oxygen depletion during, the early hours of the morning, during the first fortnight. This is evident from the occasional mortality of fishes observed during the early hours of that fortnight. This is strengthened by diurnal monitoring done on 19th and 20th (Table 4). Two areas were monitored, on 12–4–'84; Station 2 which was already depleted in oxygen and in which the bloom had died, and Canal A/B which had higher level of oxygen and contained bloom of similar composition as obtained in Station 2. Table 4 reveals the extent of depletion, upto 0.41 ml/l at 0200 hrs in the canal containing the bloom. The diurnal monitoring of environmental parameters including dissolved oxygen carried out on 19/20–4–'84 substantiated this phenomenon (Table 4). It can be confidently inferred from this, that similar oxygen depletion had occurrred in Station 2 during the fortnight prior to mass mortality.

The continuous low oxygen levels observed during the day time on 19th April may be due to decomposition of the dead fish in the water. The deterioration in water quality also led to the death and decay of marcophytes especially *Halophilla ovalis.* This would have further added to oxygen depletion of the water.

Thus when under normal circumstances the oxygen depletion in the early hours would be made up by photosynthesis during the day, recovery was not possible here due to reduction in bloom and death and decay of different organisms (Table 4).

Table 3. *Environmental parameters: Estimated values as observed during the period of mortality*

	Gross productivity (mg C/m³/day)			Chlorophyll *a* (mg/m³)			Phosphate (μg–at/l)			Nitrite (μg–at/l)			Nitrate (μg–at/l)			Ammonia (μg–at/l)		
Date	13/4	19/4	26/4	13/4	19/4	26/4	13/4	19/4	26/4	13/4	19/4	26/4	13/4	19/4	26/4	13/4	19/4	26/4
Stn. 1	111.4	—	896.2	24.1	35.5	32.4	0.52	—	N.D.	0.25	—	N.D.	N.D.	—	0.74	N.D.	—	N.D
Stn. 2	—	—	1569.4	43.9	8.6	—	0.52	1.56	N.D.	0.6	0.62	0.07	N.D.	N.D.	1.4	N.D.	29.4	N.D.
Pond A2	1710.9	—	2701.4	55.2	23.9	19.6	N.D.	—	N.D.	1.0	—	0.2	N.D.	—	N.D.	N.D.	—	N.D
Pond B2	1312.1	—	—	18.9	14.1	28.6	Tr.	—	1.3	0.65	—	0.07	N.D.	—	Tr.	N.D.	—	5.22

Table 4. *Diurnal variation in Dissolved Oxygen (Period of observation* 19–4–'83 *(1400 hrs) to* 20–4–'83 *(1100 hrs)*

Time	Station 2 Temperature (°C) Atmos.	Water	Dissolved oxygen (ml/l)	Canal between A and B series Temperature (°C) Atmos.	Water	Dissolved oxygen (ml/l)
1400	31.6	33.8	0.38	—	—	—
1700	27.6	34.0	0.78	27.6	35.1	4.45
2000	26.8	32.8	0.79	26.8	32.6	3.90
2300	26.8	31.7	0.57	26.8	31.0	2.39
0200	27.2	32.2	0.19	27.0	29.8	1.52
0500	25.8	30.8	0.19	25.6	28.8	0.41
0800	26.8	31.0	0.09	26.8	29.2	1.50
1100	27.8	33.2	1.50	27.8	33.4	3.62

Conclusion

During this season the prevailing high temperature and salinity and the enclosed nature of the water body, all resulted in an intense bloom of dinophytes. This led to oxygen depletion of the waters and then, very likely, of the mud. The environment of the closed system must have been strained to a fine degree of balance.

Another reason may be that large groups of fishermen belonging to Kovalam and Karikattukuppam villages, in view of poor fishing in the sea, started unauthorised fishing in the farm area at Muttukadu. The regular operation of drag nets and gill nets has stirred up the mud and created large scale disturbance which, combined with the oxygen depletion, must have precipitated the crisis and led to the mortality of prawns and fishes.

ON THE CAPTURE OF JUVENILES OF *LUTJANUS RUSSELLI* (BLEEKER) AND *SCATOPHAGUS ARGUS* VAR. *TETRACANTHUS* (LACEPEDE) FROM BOMBAY WATERS*

Bhokshi nets are operated regularly at Manori creek at Marve for prawns and fishes of the creek. Two *Bhokshi* nets of mesh size 4–12 cm at the mouth and 1 cm at the cod end that were operated in the creek on 14–9–'83 landed 200 kg of fishes which contained 20 kg of juveniles of two species of quality fishes as incidental catches. They were identified as *Lutjanus russelli* (Bleeker) and *Scatophagus argus* var. *tetracanthus* (Lacepede) (Figs. 1 & 2).

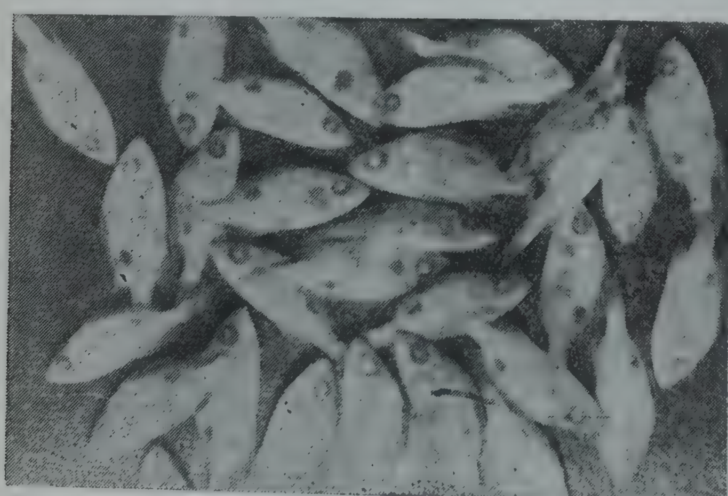

Fig. 1. Juveniles of *Lutjanus russelli* (Bleeker).

Based on this catch the number of juveniles in the fishery was estimated at 7,00,000 in the case of *L. russelli* and were observed to have a size range of 28–31 mm weighing 13.4 g on an average. The size range in case of *S. argus* was still smaller, from 12–16 mm with an average weight of 2 g. The juveniles of *S. argus* are quite different from adults as they do possess armature in the head region which disappear as they grow into adults. The length frequency histograms are presented in figs. 3 & 4.

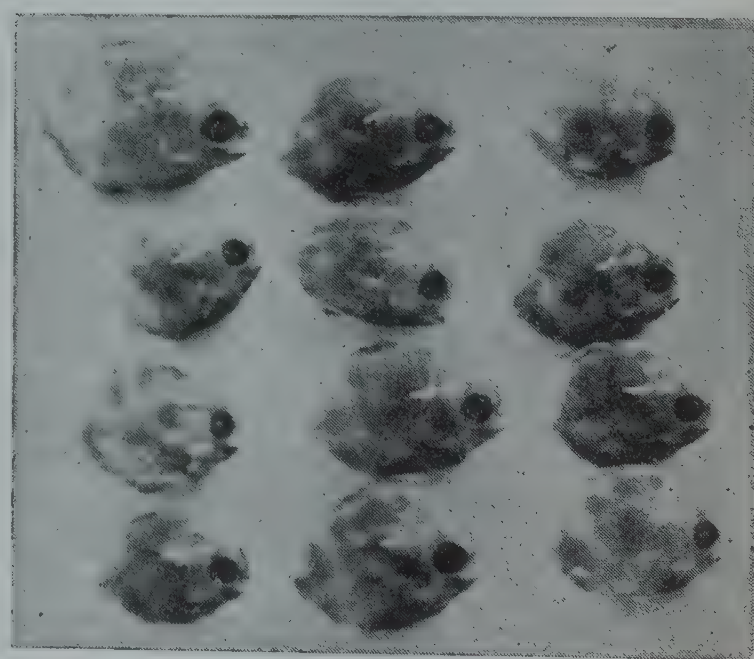

Fig. 2. Juveniles of *Scatophagus argus* var. *tetracanthus* (Lacepede)

It is quite probable that this unusual landings of juveniles in bag nets in good numbers was due to the

*Prepared by M. Aravindakshan and S. K. Chakraborty, Bombay Research Centre of C.M.F.R.I., Bombay.

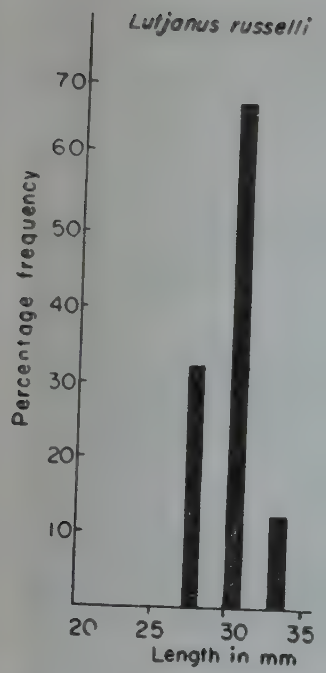

Fig. 3. Length-frequency of juveniles of *Lutjanus russelli* (Bleeker).

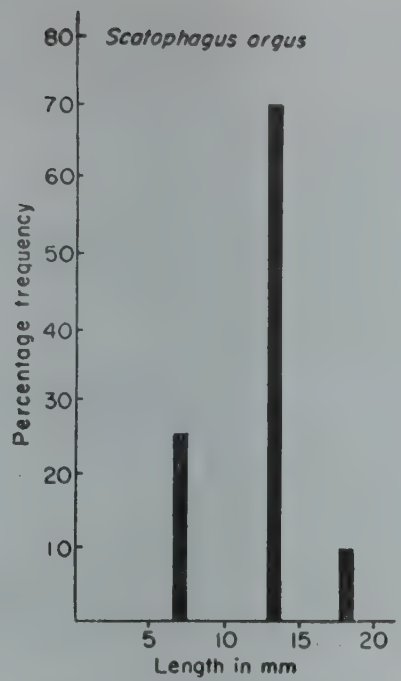

Fig. 4. Length-frequency of juveniles of *Scatophagus argus* var. *tetracanthus* (Lacepede).

young ones coming into the creek owing to the availability of food in the creeks during monsoon period and also to escape strong currents in the foreshore areas. During this period *Bhokshi* net operations are harmful for juvenile fishes and therefore it is advisable that these nets be operated with larger mesh size at the cod end. The adults of both the above cited species grow to a size of 30 cm in length and fetch a price of Rs. 2–3 in the market when sold in fresh condition. *S. argus* is however, less esteemed as food fish than *L. russelli*.

The authors are grateful to Shri A.A. Jayaprakash, Scientist S–1 for the help rendered in identifying one species as *Scatophagus argus* var. *tetracanthus* (Lacepede).

SPAWNING OF *NEMATALOSA NASUS* BLOCH IN PILLAIMADAM LAGOON AT MANDAPAM*

Marine fishes are usually not known to spawn in the coastal lagoons though such habitats constitute one of the preferred nurseries for the growth of migrating fry and fingerlings of some of the culturable species like mullets and milk fish.

During the course of the routine observations on the fishing activities of the Pillaimadam lagoon at Mandapam, large numbers of *Nematalosa nasus*, locally known as 'Koi' measuring 195–235 mm and weighing 80–140 g were caught from the lagoon (Fig. 1 c). The gonads of the fish were in ripe condition, weighing 10 to 20 g. The lagoon bar mouth which remains closed during the pre-northeast monsoon months opens with the onset of the northeast wind and the high tidal amplitude in the Palk Bay, carrying the sea water into the lagoon. Along with this tidal flow many species of fishes migrate into the lagoon, of which *N. nasus* forms a considerable percentage.

On 23–11–'83, when a trial netting was conducted by the author, using a 1 mm mesh synthetic fibre net, large numbers of transparent fry of *N. nasus* measuring 10 to 25 mm were collected (Fig. 1a). These hyaline fry were very delicate to netting operations resulting in heavy mortality. These fry were characterised by large eyes, pointed mouth, 17–19 dorsal rays and 18 to 22 anal fin rays. Fingerling of size 30 to 40 mm were collected subsequently on 17–12–'83 and 18–12–'83 (Fig. 1b). These withstood netting operations well. It was possible to transport them alive to 'hapas' erected in the shallow regions of the lagoon. Fingerlings were observed to have large eyes and terminal mouth. They were silvery in colour. Most of the adult of *N. nasus* collected from the lagoon after 10–12–'83 found

*Prepared by R. S. Lal Mohan, Mandapam Regional Centre of C.M.F.R.I., Mandapam Camp.

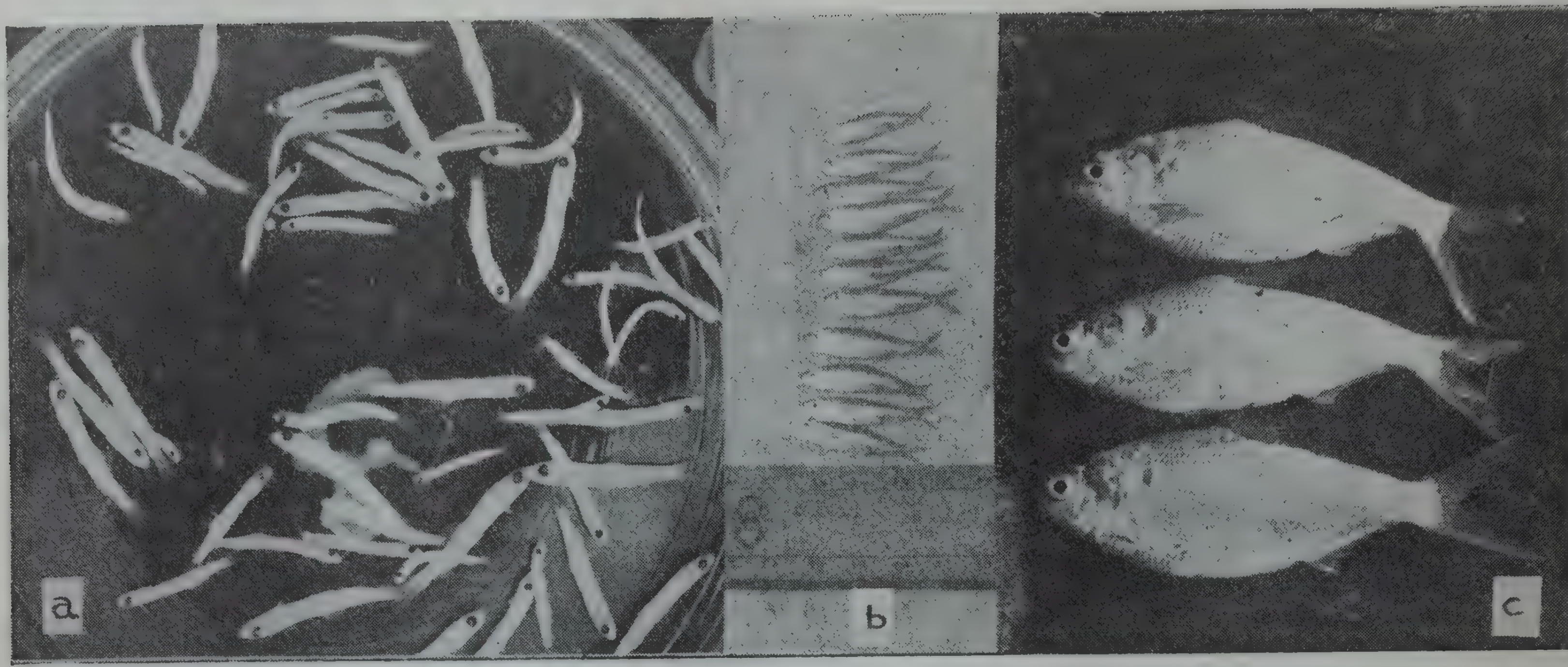

Fig. 1. *Nematalosa nasus*. a. Fry, b. Fingerlings c. adults.

to have gonads in 'spent' stage. The gonads were invariably shrivelled and weighed 2.5 to 4.0 g. However, some ovaries were vascular containing a few residual ripe ova indicating a very recent spawning. The above observations point to the probability of *N. nasus* entering the lagoon with mature gonadial condition and spawning in the water mass there. The salinity of the lagoon which was 35.2 ‰ during the first week of November came down to 28.8 ‰ during the last week of November due to the admixure of fresh water from the land on account of monsoon rain. The water temperature had dropped from 30°C to 23°C during the early hours of the morning.

Earlier observations show the possibility of *N. nasus* spawning in confined saline ponds in a salinity range of 28.0 to 32.0‰. The present observatoin of the fish spawning in coastal lagoons and ponds makes it extremely viable for culture. The observations suggest the immense possibilities of utilising the fingerling resources of *N. nasus* in the area to meet the seed requirements of this species for successful farming.

OCCURRENCE OF *TACHYSURUS DUSSUMIERI* (VALENCIENNES) WITH INCUBATING YOUNG ONES OFF MANGALORE*

During the course of routine observations on the purse-seine landings at Mangalore, a catch of about 21 t of catfish *(Tachysurus dussumieri)* was noticed on 23–3–'82. They were netted in a single haul by a purse seiner off the New Mangalore harbour at a depth of about 10 m. On a random examination of the catch it was found that all were males with fully developed young ones in their mouths. Their sizes ranged from 510 to 670 mm (average length 573.6 mm) with a mode at 589 mm and their weight varied from 1.7 to 4.0 kg with an average weight of 3.038 kg. In a sample of 30 fishes examined, the number of young ones varied from 2 to 101, with an average of 22 per fish. This indicates that the species could hold in their oro-buccal cavities as high as 100 or even more developing eggs ensuring perhaps a high hatching and survival rate. They ranged from 58 to 78 mm in total length with a mode at 67 mm (Fig. 1) and weighed between 2.7 to 4.3 g. Majority of them were fully developed, while in a few, the yolk-sac was not fully absorbed and appeared like long slits on the ventral side through which the yellow coloured unabsorbed yolk-sacs could be seen (Fig. 2).

Majority of the catfish landed had spewed out most of their young ones consequent upon their encirclement and subsequent struggle when thrown on the deck. Based on an average of 22 young ones per fish, a rough estimate of young ones destroyed amounted to 1.65 lakh in a single seining operation.

* Prepared by C. Muthiah and G. Syda Rao, Mangalore Research Centre of C. M. F. R. I.

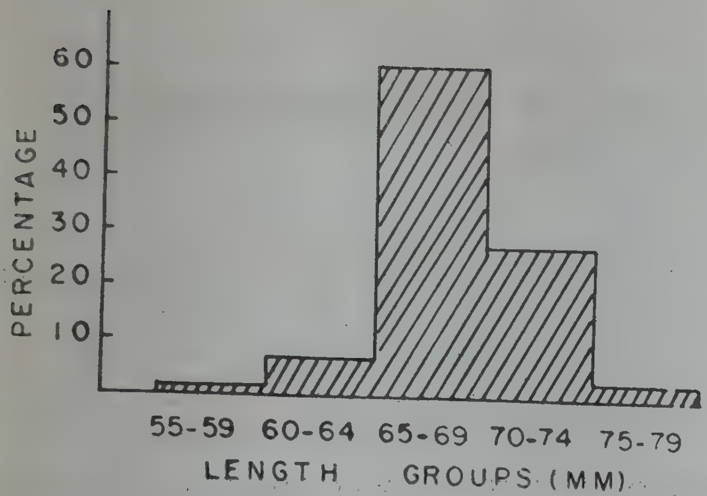

Fig. 1. Length-frequency of young ones of *T. dussumieri*.

Fig. 2. Unabsorbed yolk-sac on the ventral side of young ones of *T. dussumieri*.

Since majority (79%) of the young ones were in the 65–70 mm size group, it appears that all belong to the same spawning batch. The ova-diameter studies of ovaries in stage V maturity condition (Fig. 3), made during January, 1982 and the bimodal nature of development of eggs lend confirmatory evidence to such a view. The mode *a* at 4 mm representing immature group is clearly separated from the maturing group *b* with a mode at 14 mm destined to spawn in February.

Earlier observations along the Mangalore coast show that this species spawns only once a year during the period from December to March with peak in February. Juveniles measuring from 56 to 68 mm in total length in the oro-buccal cavities of *T. dussumieri* caught in a bag net operated in 15 to 40 m depths off Malpe and Gangulli have been recorded. Experiments conducted by the authors on the rearing of eggs of a much smaller catfish, *T. tenuispinis* (the ripe eggs of both the species have more or less the same dimensions) have shown that the embryos (8 mm in length) attained 30 mm in a period of 17 days at the time of hatching. Under natural conditions this period would be still shorter. As such it could be assumed that the young ones (58–78 mm) of *T. dussumieri* might be the product of spawning of February.

Fecundity studies of eight ovaries in maturity stages IV and V carried out in January, 1982, revealed the number of eggs varying from 176 to 207 with an average of

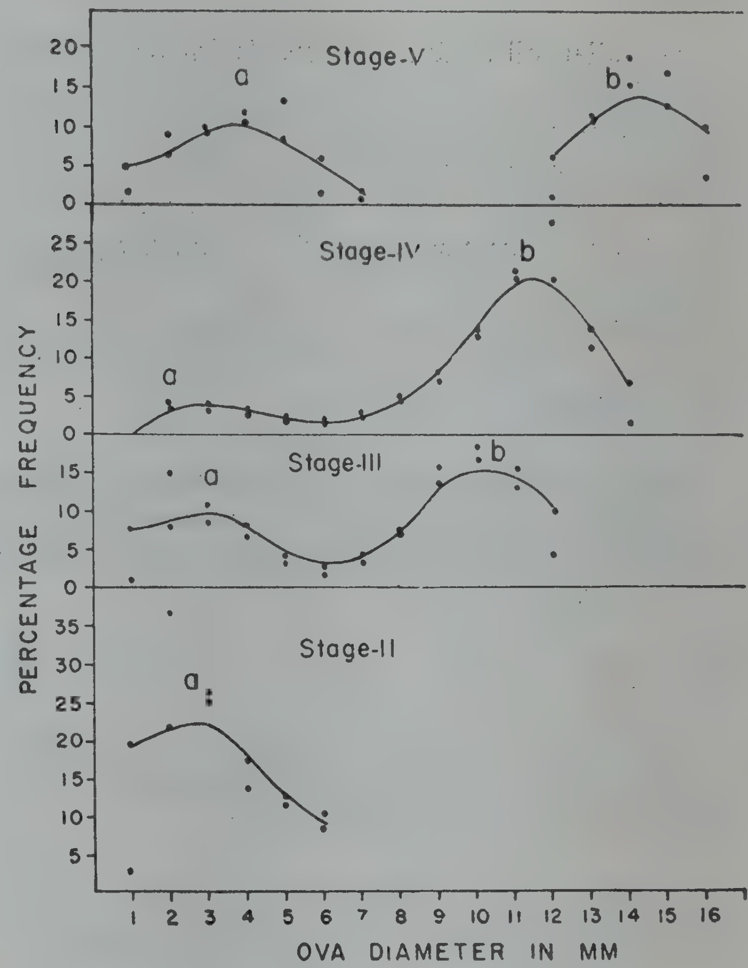

Fig. 3. Ova diameter-frequency of *T. dussumieri*.

190. In the light of the fact that a fish can hold 101 young ones in its buccal chamber as stated earlier, the survival rate for an average of 190 eggs works out to about 53%.

Mojumder *(Indian J. Fish;* **25**: 109-121, 1978) collected larvae measuring 20-30 mm of *T. thalassinus* with yolk-sac attached, from inshore waters of Lawson's Bay, Waltair. This indicates that *T. thalassinus* releases the young ones from its mouth when they are smaller in size as compared to *T. dussumieri* which retains the young ones measuring upto 78 mm in their mouth as evidenced from the present observations.

We are thankful to Dr. E. G Silas, Director, Central Marine Fisheries Research Institute, Cochin for his interest and encouragements. Thanks are due to Dr. B. Krishnamoorthy, Head, Demersal Fishery Division for critically going through the manuscript and to Shri. M. H. Dhulkhed for his valuable suggestions.

AN UNUSUAL OCCURRENCE OF OIL SARDINE IN PONDICHERRY ON EAST COAST OF INDIA*

Introduction

The Indian oil sardine, *Sardinella longiceps* Valenciennes which forms 10 to 18% of the total fish landings in India, usually occurs in shoals along the west coast of India. Only stray catches of oil sardine have been reported from the east coast. But there has been no report of its occurrence along the Pondicherry coast on the east coast except for one report in 1847 by Valenciennes from the collection of Dr. Bellenger. The only specimen measuring 15 cm collected at Pondicherry was discoloured and in bad state.

During October–December, 1983 unusual landing of oil sardine in good quantities were noticed in Pondicherry state and the present report gives a brief account of the fishery.

Catch details

Altogether 57 t of oil sardine were landed during this period. The details of catch landed in three zones in the state are given in Table 1.

It is seen from the above table that the maximum landings of oil sardine was observed in November '83, the catches of this fish in October '83 being negligible. The Zone-P_1 contributed more to the total landings than Zone P_2. The landings of oil sardines in December was poor since the fishermen preferred prawn fishing.

Table 1. *Catch details of oil sardine along the Pondicherry coast (in kg)*

Zone	Oct. '83	Nov. '83	Dec. '83
P_1	—	28,353	5,625
P_2	200	14,010	9,850
Total	200	42,363	15,475

The shoals were caught in the gill nets in depths of 6 to 8 meters just one kilometer from the shore. On 25–11–'83 the shoals were sighted very near to the shore at Pillaichavadi (Zone-P_1) which tempted the fishermen to operate the shore seine net. However, only small quantities of oil sardine were caught as the operation of shore-seine was not quick enough to encircle the shoals. Another important feature noticed was that the shoals which remained in 6 to 8 meters depth did not move to deeper areas. This was evidenced by the non-occurrence of oil sardine in the gill net that operated in deeper areas of 20 to 25 meters depth. This enabled the fishermen to choose one of the following two, either fish for oil sardines close to the coast or for other fishes in deeper areas depending upon the price available for them in the market.

The oil sardines were caught by *catamarans* using *kavala valai* and *thattakavala valai,* with the mesh size ranging from 2.5 to 4 cm. However, the fishermen preferred only *kavala valai* which has a mesh size of 3 cm for it was more efficient in catching oil sardines. From the observations made, it was found that the catches from *thattakavala valai* were bigger in size.

Biological Observations

The fishes caught in the *kavalavalai* ranged between 140 and 164 mm with the dominant size around 150 mm. The size range of fishes caught in the *thattakavala valai* was between 154 and 202 mm with majority around 170 mm.

The size range in November was from 144 to 202 mm, while in December the range observed was from 142 to 162 mm. It is presumed that the shoals belonged to the 1st, 2nd and 3rd year groups. Females outnumbered the males and were immature being in first and second stages of maturity.

General observations

The sea around Pondicherry is usually rough and in tubrid condition during the northeast monsoon

* Prepared by S. Srinivasarengan, MRC of C. M. F. R. I., Madras and L. Chidambaram, Field Centre of C.M.F.R.I., Pondicherry.

period, especially in the month of November. Further, during this period, under water drift locally called *vannivellam* flowing towards south used to be observed. However, during the period of present observations *sonivellam* alias *thentivellam* (drift flowing towards north) was strong instead of the usual southward drift *(vannivellam)*. This was an unusual feature at this coast during monsoon months especially in November. This feature might have been a cause for the abundance of oil sardine in large quantities along the Pondicherry coast.

We are grateful to Dr. E. G. Silas, Director for encouragement and Shri G. Venkataraman and Shri D. S. Rao for critically going through the manuscript and giving suggestions for the improvement of the report.

Compiled and prepared by Dr. M. J. George, Dr. K. J. Mathew, Mr. G. Nandakumar &Miss Jancy Jacob
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Abbreviation – *Mar. Fish. Infor. Serv. T & E Ser.,* No. 62: 1985

CONTENTS

Cover photo : Fish farm in Cochin backwater area among coconut groves. Part of harvest is shown in inset

FIN FISH CULTURE

S. Mahadevan

Regional Centre of C.M.F.R.I., Mandapam Camp

Introduction

The potential inshore area in less than 18 m depth available for near sea farming along our coast is estimated to be of the order of 9 million hectares. But this zone is subject to the vagaries of the southwest and northeast monsoons. Sheltered bays with marine condition are restricted only to Andaman and Nicobar islands and Lakshadweep Archipelago. The paucity of such ideal bays for fish culture is compensated by extensive backwater areas at numerous river mouths, tidal creeks/inlets, mangrove swamps and lagoons. The total area under this complex ecosystem is estimated to be 2 million hectares. Out of this, the 'Pokkali' fields of Kerala, 'Bheris' of West Bengal, 'Gazani' farms of Karnataka and 'Khazan' lands of Goa accounting for 30,000 ha are known to be used for traditional and historical practice of fin fish culture raising the two major cultivable groups of fin fishes namely, mullets and milkfish with an annual yield known to vary from 35 – 750 kg/ha/year, depending on several factors. The pearl spot, bhekti, sand whiting and thread fins are also often grown. In other maritime states like Andhra, Tamil Nadu and Maharashtra hardly any cultivation in backwater is known except for a 100 ha area used in Gujarat.

The pioneering suggestion made eight decades ago to contemplate marine fish culture in India came from Hornell (1911). His later effort in 1915 to establish a fish farm in the Hare Island area at Tuticorin received a set back after inital experiments due to extreme difficulties in farm management during northeast monsoon season. Consequently the farm was abandoned. Fish farming work in Kerala started in 1940 at Narakkal, growing mullets and milkfish along with prawns in about 100 ha which gave encouraging production of nearly 1,000 kg/ha/year. The Madras Fisheries Department renewed fish farming experiments in 1944 by constructing a farm in a tide fed marshy swamp at Krusadai Island, near Pamban, for growing milkfish and mullets. Recurring hardship and handicaps forced discontinuance of these experiments also. Such trials in farming efforts underlined the paramount need for accelerated involvement to evolve suitable farm management strategies for different ecological niche.

Awareness was also created to focus our attention on several areas such as knowledge of the influence of water temperature and salinity in the grow-out systems on the candidate species cultured, understanding of the interaction of several environmental parameters in the culture system, basic productivity of different habitats, availability of suitable sites based on soil types and microfauna production, seed stock availability in space and time and devising techniques of transporting the seeds from areas of availability to areas needing them. Evolving appropriate growing techniques and assessing the production capabilitites of different methods were identified as priority areas for experimentation.

Fin fish culture in C. M. F. R. I.

In this context it will be of interest to mention here the significant advances made by the C.M.F.R. Institute in fin fish farming research. Pond culture experiments carried out by Tampi (1960) in saline mud flat at Mandapam emphasised the need for compensating the porous, loamy soil character of the area with low nutrient contents by improving pond designs and supplementing the food energy source. Other crucial problems to be solved were (a) overcoming disadvantages encountered during cyclonic months resulting in tidal erosion of bunds (b) avoiding silting of water supply channels at the water front due to tidal action and (c) solving the problem of low profile tidal amplitude during many months resulting in scanty water exchange in the ponds affecting the water quality. These adverse factors were considered common to other sectors of the east coast as well and called for improved

Fig. 1. A view of some ponds constructed with granite and cement (Photo: Courtesy of Shri P. Bensam).

Fig. 2 & 3. Supply canal for flowing sea water into culture ponds. (Photo: Courtesy of Shri P. Bensam).

Fig. 4. Pumping of sea water into ponds. Sides of ponds protected by palmyrah rachis to prevent erosion on rainy days. (Photo: Courtesy of Shri P. Bensam).

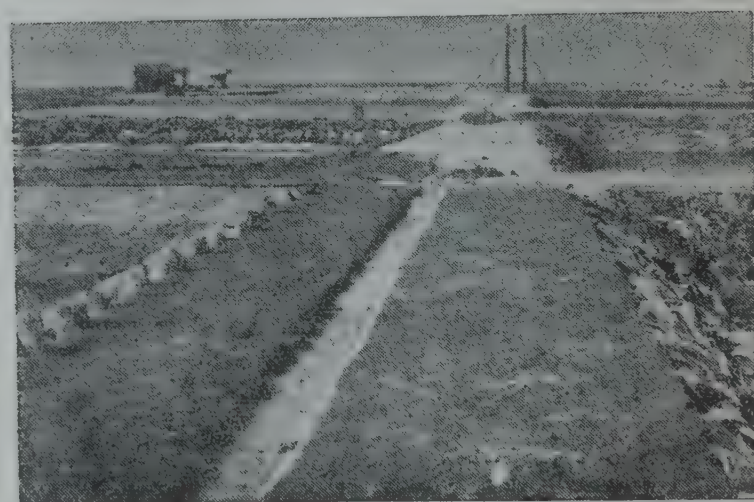

Fig. 5. Experimentation by lining pond slopes with palmyrah leaves, in order to make the dykes durable (Photo: Courtesy of Shri P. Bensam).

Fig. 6. Removing mangrove vegetation and constructing ponds at Tuticorin. (Photo: Courtesy of Shri R. Marichamy).

low cost designs in pond construction and water supply management plans.

Long after the farm at Mandapam was raged by the tidal bore during a cyclone which hit the Palk Bay coast, a set of 7 ponds were reconstructed in 1977 at Mandapam (in a 1.0 ha area of the saline flat) providing granite stone revetment for pond bund slopes, strong sluice for automatic exchange of tidal water to and from each pond and a common, concrete supply channel leading from the sea controlled by shutter sluice to let in and let out water (Figs. 1, 2 and 3).

Subsequently another 2 ha plot was converted into 21 earth excavated ponds of different dimensions with arrangements for water supply through direct pumping. The bunds were effectively turfed with sea water resistant grass and bund slopes held compact by palmyrah leaf matting all over (Figs. 4 and 5). The above systems worked very satisfactorily facilitating farming experiments for the last five years.

Experiments to harness the mangrove vegetated areas for pond culture were tried at Tuticorin from 1977. A portion of mangrove fringed water expanse of 15 ha was initially compartmentalised into 6 ponds (each 0.25 ha) with strong bunds using the clay removed during excavation. Water exchange to all ponds was ensured by digging a tide fed supply channel, and the entry and exit of water were regulated by P.V.C. pipes connecting the channel to the ponds. Tufts of mangrove plants with the rhizophores were left intact unremoved, here and there, to serve as shaded shelter for the pond stock and for affording refuge to natural mangrove associated fauna to coexist (Figs. 6 and 7). The ponds have withstood monsoon seasons well.

At Madras, also a portion of saline water spread of about 50 ha at Muttukad was converted into a fish farm during the last two years (Figs. 8 and 9). It is too early to assess the performance.

Pond culture: Experiments conducted so far in Tuticorin and Mandapam using ponds were mostly for milkfish and mullets although the Indian sand whiting was also stocked at Mandapam occasionally. Monoculture and mixed culture were attempted. Interesting results have been obtained as evidenced by the reports of James (1983), James, *et al.* (1980b, 1983), Silas *et al.* (1983), Mohanraj *et al.* (1983) and Marichamy and Rajapackiam (1982). Polyculture of *Chanos, Velamugil seheli, Liza macrolepis* and *Penaeus indicus* has been shown to be very productive (1,364.4–1,864.5 kg/ha) while mixed culture of *V.seheli* and *Chanos* also yielded 1,422.2–1,600 kg/ha in 1980–82 experiments at Mandapam. Monoculture of *V. seheli* and *Chanos* did not yeild production rate in excess of 358.2 kg/ha except in one year (81–82) when the production of *Chanos* grew to 852 kg/ha. During 1977–1979 Polyculture experiments at Tuticorin, an estimated production value of 499 kg to 731 kg/ha/yr of milkfish, mullet and prawn was obtained by Marichamy and Rajapackiam (1982).

In the Polyculture experiments with *Chanos chanos, L.macrolepis* and *Scylla serrata* at Tuticorin a production of 1,644 kg/ha/yr has also been reported. The striking aspect of the experiments was that the yield was encouraging enough to attempt further experiments to perfect and standardise the farming techniques.

Salt pan fish culture: This was yet another trial to find out whether vast areas of salt pans in the east coast could be profitably utilised for farming milkfish and mullets. During 1973–75 experiments in the salt pans at Veppalodai near Tuticorin (Fig. 10) Bensam and Marichamy (1982) reported about the possibility of harvesting 857.47 kg/ha of milkfish in 14 months. It was observed that the survival range of 44–85% could be further improved with predator control.

Pen culture: In view of the operational and experimental success of pen enclosures for growing fishes in countries like Malaysia, Singapore, Thailand and Philippines experiments were undertaken in India also to identify suitable areas and show the production capabilities. The inital experiments at Tuticorin 1973 using bamboo screen pens to grow *Chanos* and mullets in a selected area with shallow muddy bottom flopped due to technical defects in pen construction and site selection (Shanmugam and Bensam, 1982).

During 1976–78, bamboo screen pen enclosures (81 m^2 area) were put up in the Gulf of Mannar at Mandapam for growing milkfish and mullets (Venkataraman *et al.* 1980). Except for the details of growth of *Chanos* from 60 mm to 217 mm in 4 months (average growth 51 mm per month) production data are wanting for these experiments.

A more positive contribution in pen culture was the *utilisation of hypersaline, lagoon* area of Mandapam for growing *Chanos* in pen enclosures. The work was initiated in 1982 and an area of 2.25 ha in an expanse of 230 hectares of Pillaimadam lagoon acquired by CMFRI was converted as pen enclosures by erecting net screens (using 20 mm mesh nylon webbing) dividing the area into 5 compartments ranging from 0.25–1.00 ha (Fig. 11). Stocking the pens with 80–100 mm fingerlings of milkfish a growth rate of 450 mm in 180 days has been reported (Lal Mohan, 1983). Attempts to lower the hypersaline conditions (60–180‰) during certain months (due to evaporation) by keeping the bar mouth open not only helped to increase the standing water column inside the lagoon but also to bring down the salinity considerably. The production capability is estimated to be around 2,000 kg/ha (Lal Mohan, personal communication). This remains to be substantiated in the coming years.

Fig. 7. View of coastal ponds developed along Tuticorin Bay (Karapad). (Photo: Courtesy of Shri R. Marichamy).

Fig. 8. General view of earthern ponds at Mariculture Centre of CMFRI, Muttukad. (Photo: Courtesy of S/Shri. P. R.S. Tampi and M. Kathirvel).

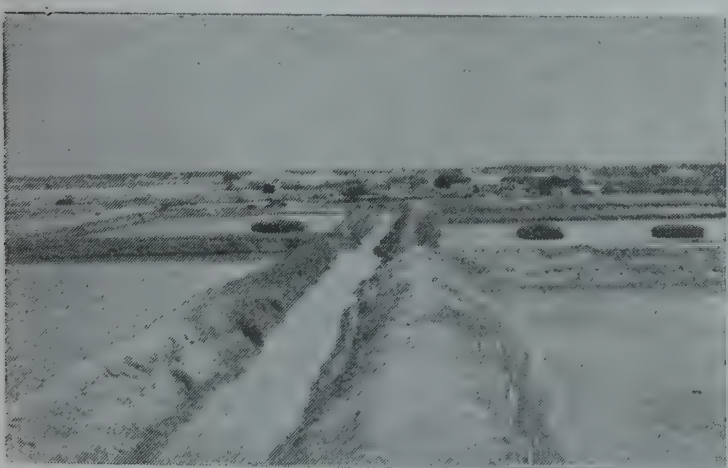

Fig. 9. Close-up view of earthern ponds. (Photo: Courtesy of S/Shri. P.R.S. Tampi and M. Kathirvel).

Fig. 10. View of fish ponds in salt pan area at Veppalodai. (Photo: Courtesy of Shri. R. Marichamy).

Fig. 11. Pen enclosure at Pillaimadam lagoon, Mandapam. (Photo: Courtesy of Dr. R. S. Lal Mohan).

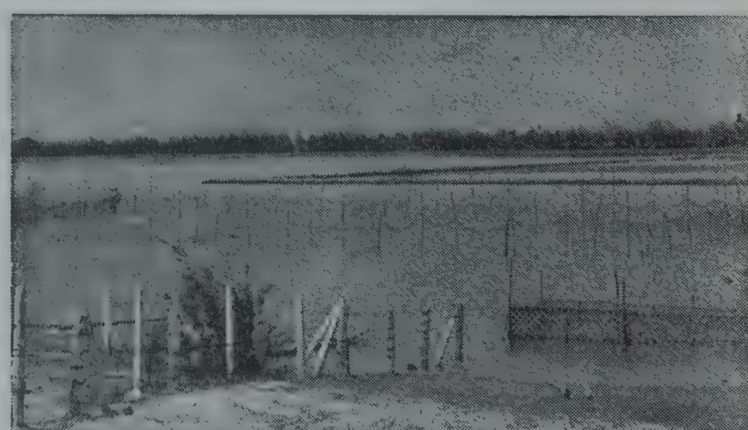

Fig. 12. Pen enclosure at Muttukadu, Madras. (Photo: Courtesy of S/Shri. P.R.S. Tampi and M. Kathirvel).

Recently a few net pens have been erected (Fig. 12) in the Muttukad farm, (near Madras), by the Institute for studying the growth of *Chanos chanos*. Results are awaited.

Cage culture: Cage culture is a new experience in India. But considering the great potential it holds, it was decided to attempt this method for growing groupers and rabbit fishes at Mandapam. James *et al.* (1980a) tried the possibility of culturing *Siganus, Sillago* and *Epinephelus* using fixed cages made up of nylon nettings and palmyrah leaf stilts in the coastal areas of Palk Bay near Mandapam. The experiments did not last long enough to give any quantitative

assessment. Recently cage culture work at Mandapam has been restarted using new cage designs for growing *E. tauvina* and *Siganus*, in a total area of 250 m². The work has just commenced and the results will be closely watched.

Apart from the above, Lal Mohan and Nandakumar (1981) attempted rearing milkfish and pearl spot in ponds excavated in the sandy shore of Calicut. Polythene sheets were used to cover the entire pond bottom and sides for water retention. It has been reported that it is possible to achieve a production of 920 kg/ha in 7 months in the case of *Chanos* and 380 kg/ha in 15 months for pearl spot.

Tank culture of eel: Experimental culture of the eel *Anguilla bicolor* was conducted at Mandapam during 1974–76 in running water in fibreglass tanks. It was seen that they could grow to 27.8 cm (43 g), 38.9 cm (115 g) and 41.9 cm (177 g) in the first, second and third years respectively.

The production in outdoor tanks using recycled water was still greater (rate 2.15 kg/m²) in 5 months. The eels were fed with silver belly and prawn flesh which gave better conversion ratio (7:1) than when fed with sardine and clam meat (MFIS, **23**, 1980).

Remarks

It is difficult to review here all efforts in fin fish culture that might have been made by different states and Governmental agencies. After the initial experiments at Mandapam during 60's it is less than a decade since the C.M.F.R.I., formulated projects and experiments on fin fish culture. From these experiments varying results regarding the production capability have been obtained for different locations and for different methods of culture. But when compared with the low yield of the traditional coastal culture (35.5 kg in Gujarat, 258 kg in Karnataka, 700 kg in Kerala and 300 kg/ha/yr in West Bengal) the results obtained in controlled culture is rather impressive. In most of the experiments in the ponds, natural food availability has been supplemented with the addition of artificial feed in the form of oil cakes and rice bran at 10% of the body weight of fishes. While this imposes a burden on the cost of production it has enhanced production rate/ha.

Although other allied investigations engaging the attention of the Institute with regard to problems connected with the fish culture have not been elaborated in this review it may be mentioned here that commendable progress has been made by the scientists of the Institute in assessing the productivity of the coastal areas and documenting data on the seed stock availability of culturable species along the Indian coast. The Fishery Environment Management Division of CMFRI, has been conducting special survey using the mobile laboratory along the Tamil Nadu coast on a phased programme since 1983 to study the ecosystem along the coast to find suitable areas for sea farming. Five estuarine regions and one large swamp in the area between Devipatnam near Mandapam and Nagoor at Karaikal have already been completed. Dry organic carbon in %, dry wt fishing varying from 0.061 to 2.859 has been reported. This is considered as a fairly high value of productivity for the regions studied. Investigations during 1976–81 in 3 centres each in Kerala and Tamil Nadu have enabled identifying areas of abundance of seeds of *Mugil cephalus, Liza macrolepis, Velamugil seheli, Sillago sihama, Siganus javus, Etroplus suratensis, Chanos chanos, Lates calcarifer* and *Anguilla bicolor*. Safe methods for transporting the fry/fingerlings/elvers by using oxygen filled seed bottles have been successfully experimented upon.

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ARTISANAL FISHERY FOR PRAWNS AT UPPADA NEAR KAKINADA IN ANDHRA PRADESH COAST*

Introduction

Uppada (Lat. 17° 6′ N, Long 82° 23′ E) is an important marine fish landing centre of Kakinada region where prawns form about 4% to 95% in the total fish landings. Apart from the studies of Rao *(Indian J. Fish.* **26:** 52–64, 1981) on the marine prawn fishery at Kakinada by shore seine there are no other, reports on this aspect by indigenous gear from this region. Hence studies on the prawn fishery by indigenous gear at Uppada were initiated from January 1979, and the results of a five year study conducted during '79–83 are reported here. Ramamurthy and Muthu *(CMFRI. Bull.* **14:** 235–258, 1969) dealt with the craft and gear of Andhra coast.

Area of operation

Artisanal fishermen from Subbammapeta, Pallipeta, Kothapeta, Jagga Rajupeta, Ramisettypeta, Suradapeta, Mayapatnam and Ameenabad villages with indigenous craft and gear land their catches. Non-powered catamarans and the *Masula* boats operate different gears in 10–45 m depth.

Gears Operated

a) *Nylon gillnet:* There are four types of nets; *Madras* and *Jookavala*, mesh size 1.5–3 cm, *Big silk net*, mesh size 3–5cm and *Kilevala* (small silk net), mesh size 1.5–2 cm.

b) *Boat seine:* mesh size 1–2 cm at the cod end.

c) *Chinna alivi* (small shore seine), mesh size 0.5–1.5 cm at cod end and shore seine (big), mesh size 1.5–2 cm.

*Prepared by S. Lalitha Devi, Kakinada Research Centre of CMFRI, Kakinada.

Species exploited

Twenty three species of penaeid prawns and 4 species of non-penaeid prawns contribute to the prawn fishery of which 10 species of penaeid prawns and 3 species of non-penaeid prawns form regular fishery, throughout the year.

Species that contribute to the penaeid prawn fishery are *Penaeus indicus, P. monodon, P. merguiensis, P. semisulcatus, P. japonicus, Metapenaeus monoceros, M. dobsoni, M. brevicornis, M. affinis, M. ensis, Parapenaeopsis sculptilis, P. stylifera, P. hardwickii, P. probata, P. cornuta, P. acclivirostris, Solenocera crassicornis, Metapenaeopsis sp., Parapenaeus longipes, Atypopenaeus stridulans, Trachypenaeus curvirostris* and *T. sedili.*

The non-penaeid prawns are *Acetes* sp., *Exhippolysmata ensirostris, Nematopalaemon tenuipes* and *Exopalaemon styliferus.*

Gearwise catches

The yearly total catch of prawns, the catch rates (catch/unit), monthly trends of average catch by different gears are presented in Figs 1 and 2. In the following account, the trend of prawn fishery by different gears are given.

Nylon gillnet: These nets contributed to an average annual prawn catch of 41.05 t. Prawns formed nil to 3.8% in total fish landings by *Madras, Jooka,* and *Big silk nets* and 30–72% by *Kilevala.* The catch rates varied from 0.28 kg/unit to 1.1 kg/unit with an average of 0.73 kg/unit. *P. indicus, M. brevicornis, P. monodon, P. merguiensis, M. affinis, P. semisulcatus, P. japonicus* and *P. stylifera* contributed to the fishery

in the order of abundance. Prawns are caught in the gill nets throughout the year with peak landings in January and September to October.

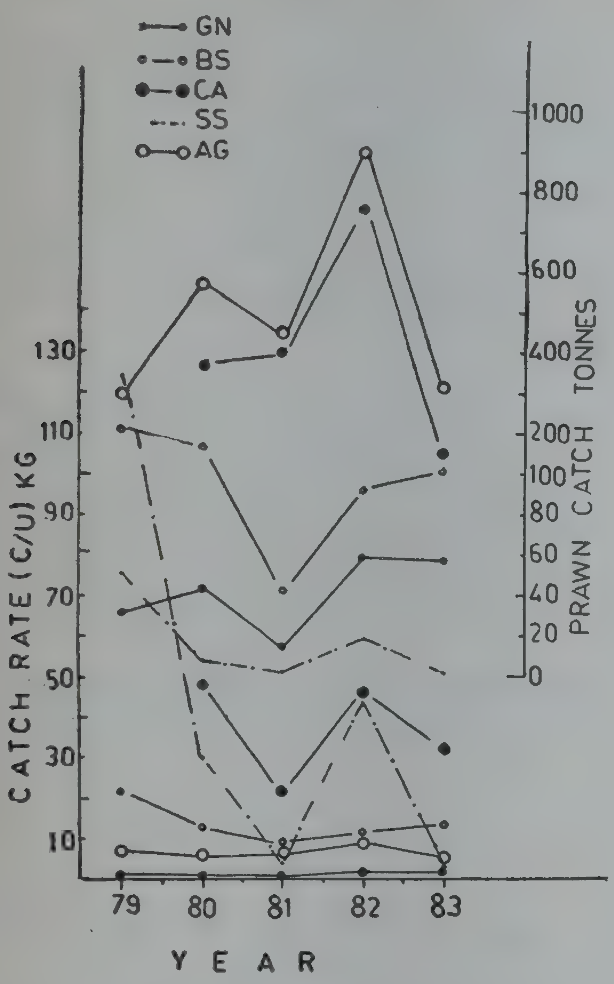


Fig. 1. Trends in the annual catch rates (C/U) of gillnet (GN), chinna alivi (CA), boat-seine (BS), shore-seine (SS) and all gears (AG) during the years from 1979 to 1983.

Boat seine: Average annual prawn landings are estimated at 119.39 t which was 22.55% in total fish catch. The unitwise catch rates varied from 8.95 kg to 22.04 kg with an average of 14.05 kg which accounted for 7.62% to 66.18% of the total fish landings. Penaeid prawns formed 46.74% and non-penaeid prawns 53.26%. *M. dobsoni, P. stylifera, P. hardwickii, M. brevicornis, M. monoceros, P. indicus, M. affinis, S. crassicornis, P. cornuta* and *P. acclivirostris* contributed to the penaeid prawn fishery in the order of abundance. *Acetes* sp., *N. tenuipes E. styliferus* and *E. ensirostris* are the important non-penaeids in the order of abundance. Catches were good from June to September and in December with peak landings during August and September.

Chinna alivi: Average annual prawn catch by this gear amounted to 326.51 t, accounting for 94.78% of the total fish landings with an average catch rate of 35.58 kg/unit. The catch rates varied from 21.90 kg/unit to 48.30 kg/unit, accounting for 85.65% to 98.69% in the total fish landings. Penaeid prawns formed 92.79% on an average and non-penaeid prawns 7.21%. In 1979, non-penaeids accounted for 29.72%.

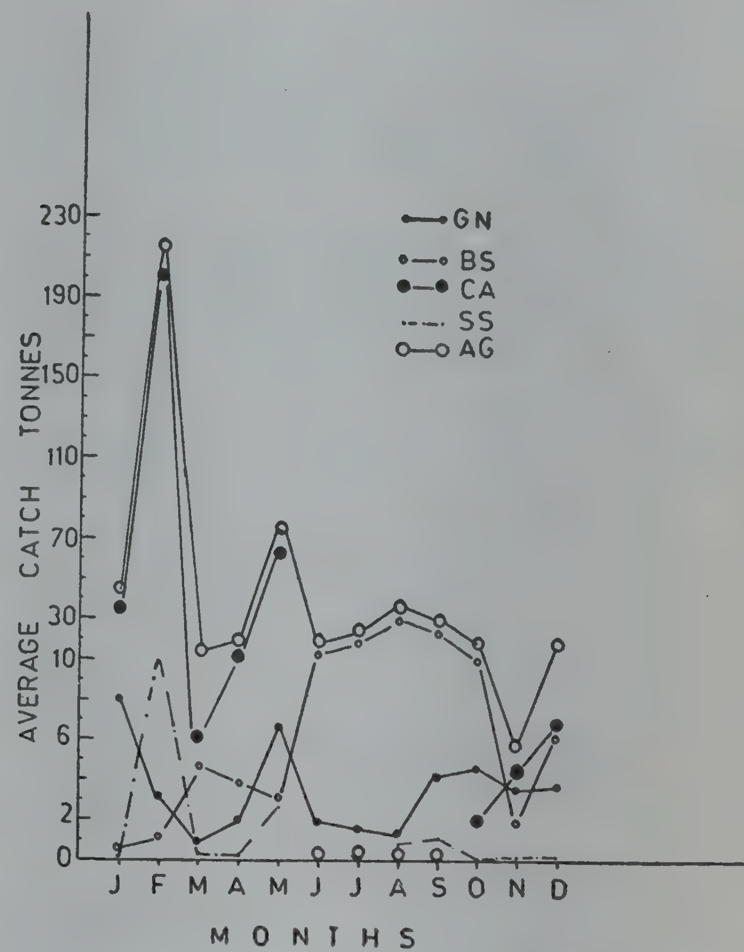


Fig. 2. Trends in the average monthly catch rates (C/U) of gillnet (GN), chinna alivi (CA), boat-seine (BS), shore seine (SS) and all gears (AG).

M. dobsoni, P. indicus, M. monoceros, P. stylifera, M. brevicornis, P. merguiensis and *P. monodon* contributed to the penaeid prawn fishery in the order of abundance. *Acetes* sp., *N. tenuipes, E. ensirostris* and *E. styliferus* contributed to the non-penaeid prawn fishery in the order of abundance. Using this gear prawns are caught in considerable quantities during the season May to December.

Shore seine: Estimated average annual catch of prawns is 14.53 t, which accounted for 11.49% of the total fish landings. The catch rates ranged from 1.31 kg/unit in '83 to 123.52 kg/unit in '79, with an average of 44.75 kg/unit. Penaeid prawns formed 90.9% and the balance by non-penaeids. Important penaeid prawns in the order of abundance are *M. dobsoni, M. brevicornis, M. monoceros, P. indicus, P. acclivirostris, P. japonicus, P. stylifera, M. ensis, P. sculptilis* and *P. hardwickii.* Fishery lasts from

November to May, with good landings in February and May.

Biological notes on the commercially important prawns

Penaeid prawns

P. indicus: This was a major component of the nylon gill net prawn fishery at Uppada, contributing 60–90% of the prawn landings. Annual landings were estimated at 38.09 t.

The length ranged from 50 to 216 mm and modal sizes from 95 to 179 mm. In most of the months, the modes ranged between 130–149 mm. Preponderance of females over males was observed, except in January to February and April to May of 1980 and '81. Mature females were found throughout the year with two peaks in January–April and August–October (Fig. 3).

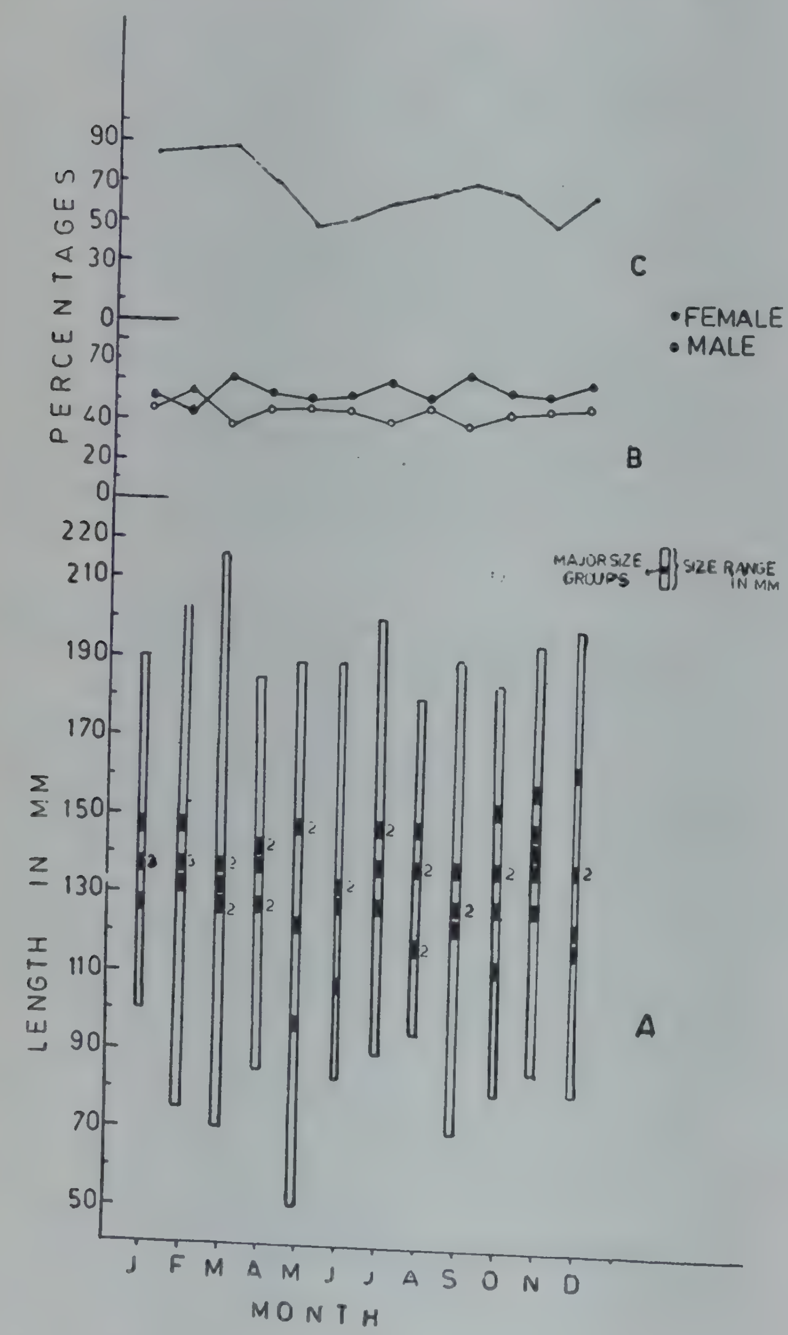


Fig. 3. Biological notes on *Penaeus indicus.*
*A. Size range and modal size in mm.
B. Sex ratio in percentage.
C. Mature females in percentage (stages III, IV & V).

M. dobsoni: This was another important species caught in 'chinna alivi', boat seine and shore seine, and ranked 1st among the penaeid prawns. The average annual landings were estimated at 267.83 t, forming about 65 % of the total penaeid prawn landings of this centre. Landings were good from December to May with peak landings during January to March.

The size ranged from 50–119 mm, with majority of them in the model size ranging from 50–70 mm during December–April and 80–99 mm during June–November. Females outnumbered males in all the months. Mature females were present in abundance during August–November and January–February (Fig. 4).

M. brevicornis: Average annual landings of this species were estimated at 21.19 t forming about

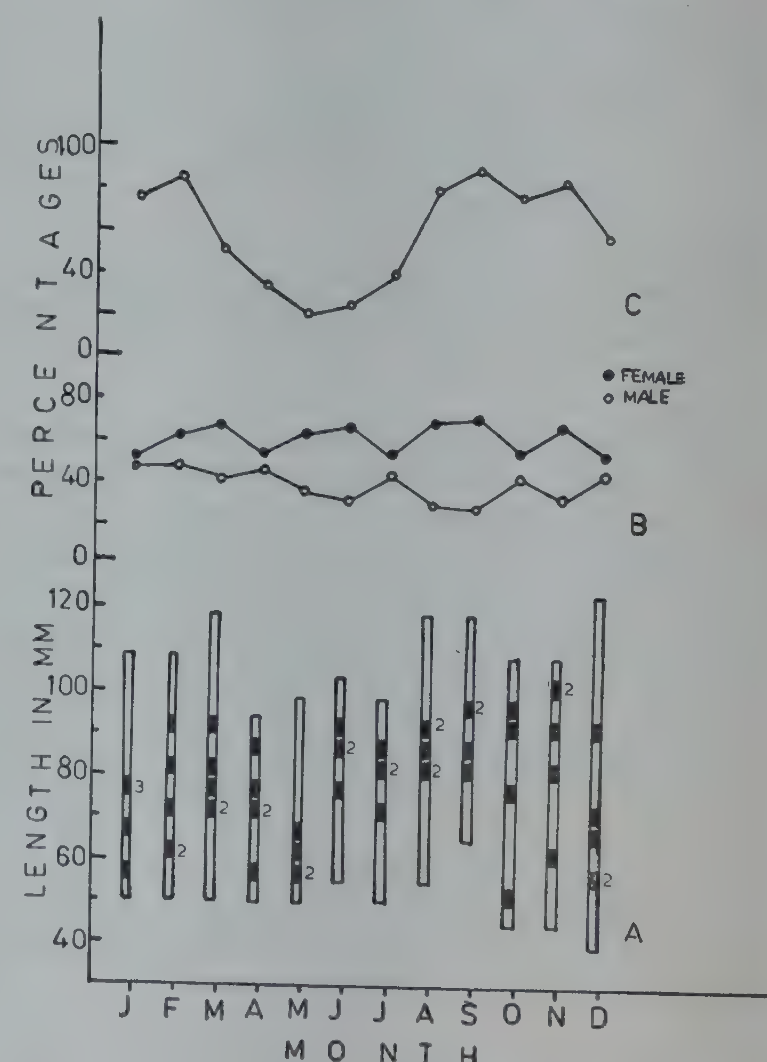


Fig. 4. Biological notes on *Metapenaeus dobsoni.*
A. Size range and modal size.
B. Sex ratio in percentage.
C. Mature females in percentage.

5% of the penaeid prawn catches. The landings were considerable during January–February and September–November. Size ranged from 50–164 mm, with majority of prawns in 110–120 mm size range in most of the months of the year. Females outnumbered males during the period of observation. Mature females occurred throughout the year with peak abundance during August–October and February–March (Fig. 5).

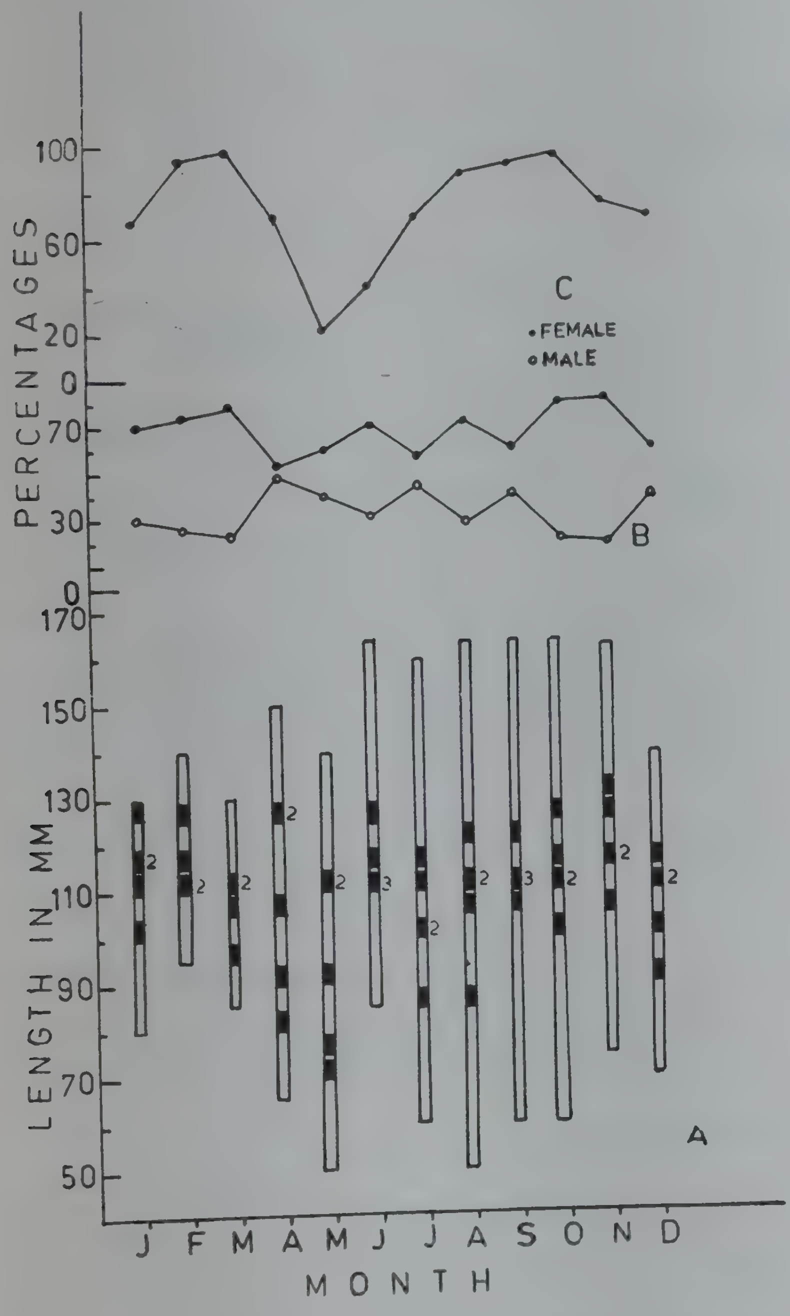


Fig. 5. A–C. Size range and modal size, sex ratio in percentage and mature females in percentage of *M. brevicornis*.

P. stylifera ranked 4th in total penaeid prawn catches with average annual landings at 20.65 t. Mostly boat seines, shoreseines and 'chinna alivi' landed this species in good quantities during August–November and February–March.

M. monoceros: Average annual landings were estimated at 15.08 t, forming 4% of the penaeid prawn catches. The fishery was good during August–September and in February.

The size ranged from 60–169 mm, with majority of prawns in 120–129 mm size group. Males outnumbered females during January–March and in August. Thirty per cent females in mature condition occurred during July–Septembeı.

P. monodon: The average annual catch was estimated at 8.1 t and it formed 2% of the penaeid prawns landings. Fishery was good during September–November and January–February.

P. merguiensis: On an average 8.11 t of this species were landed per year which accounted for 2% of the penaeid prawn catches. Fishery was good during January–February and July–September.

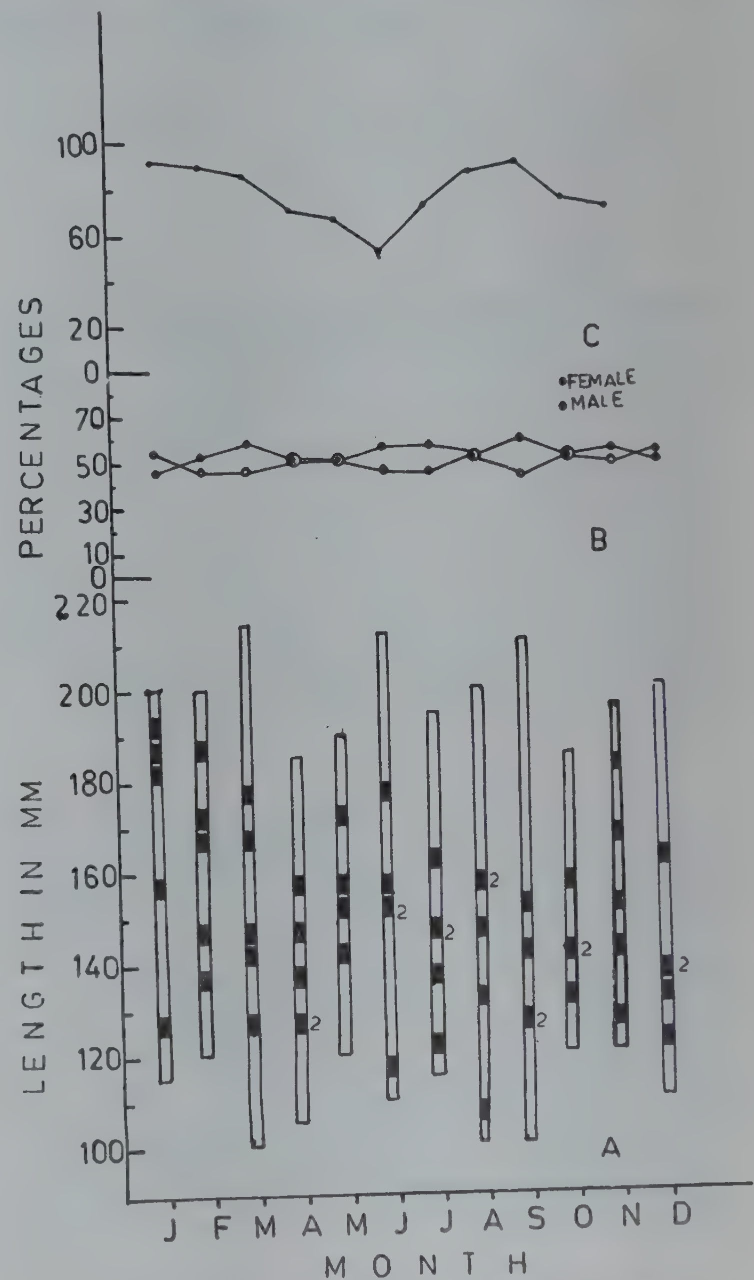


Fig. 6. *P. merguiensis.* A–C. Size range and modal size, sex ratio in percentage and mature females.

Sizes ranged from 100–214 mm, with majority in the size range 170–190 mm during January–February and 120–140 mm during the rest of the year. Males and females were found almost in 1:1 ratio, with slight predominence of females during January–March and September–November (Fig. 6).

Non-penaeid prawns

Acetes sp: This species ranked 1st in the total non-penaeid prawn catches with average annual landings at 60.2 t. Mostly boat seines and 'chinna alivi' landed this species in good quantities during May–September with peak landings during August.

N. tenuipes: Its average annual landings amounted to 15.6 t ranking 2nd in the non-penaeid prawn landings. Size ranged from 25–78 mm with majority of prawns in the 40–55 mm groups (Fig. 7). Females outnumbered males throughout with above 70% females in mature condition (late maturing and berried) during July–December. Landings were good during May to October with peak landings in July.

E. ensirostris: This species amounted to 8.1 t on an average, accounting for 9% in the non-penaeid prawn landings. Size ranged from 25–84 mm with majority of prawns in 50–60 mm modal size (Fig.8). Females outnumbered males throughout the year. Mature females occurred throughout the year with above 60% females in berried condition in April and September.

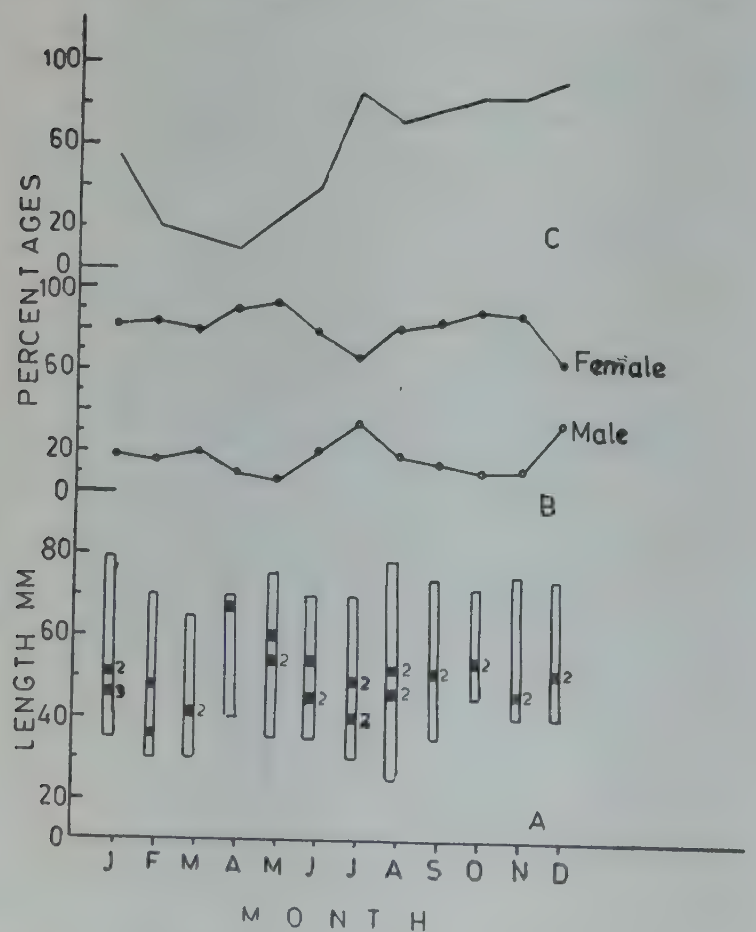


Fig. 7. *N. tenuipes* A–C. Size range and modal size, sex ratio in percentage and mature females.

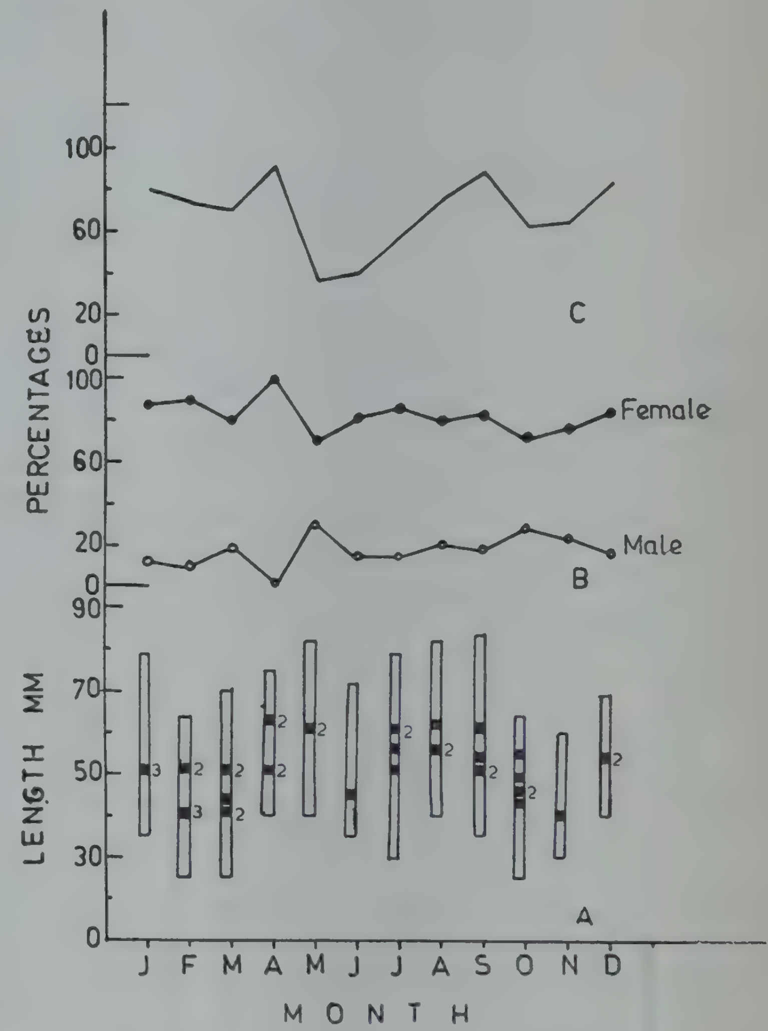


Fig. 8. *E. ensirostris.* A-C. Size range and model size, sex ratio in percentage and mature females.
*Number in Figs. 3A–8A indicates the *No.* of times that particular modal size has occurred during 79–83.

General remarks

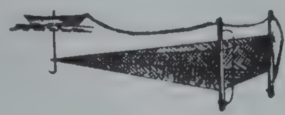
Data on prawn catches at Uppada collected for a period of 5 years from 1979 to 1983 show that an average 501.5 t of prawns are landed per annum at this centre, accounting for 24.1% of the total fish landings. Penaeid prawns formed 82.4% in total prawn landings and 19.8% in total fish landings. The chief constituents of penaeid prawn fishery are *M. dobsoni, P. stylifera, P. hardwickii, M. brevicornis, M. monoceros, P. indicus, M. affinis* and *S. crassicornis* in the order of abundance.

Non-penaeid prawns accounted for 17.6% in total prawn landings and 4.3% in total fish landings. *Acetes* sp., *N. tenuipes* and *E. ensirostris* contributed to the fishery in the order of abundance.

Prawn fishery at Uppada is carried out throughout the year. Year to year fluctuations were noticed with maximum landings during 1982 and minimum in 1979; and catches declined in '83. Generally prawn landings were appreciable during January, February, May and July to October, with peak in February, May and August. Year to year fluctuations in the prawn landings of different gears were noticed, and the minimum and maximum sizes of the prawns caught in different gears were 85–249 mm by gillnets, and 25–170 mm by chinna alivi 30–185 mm by boat seines and 25–210 mm by shore seines.

From the foregoing observations it is seen that out of 4 gears operated at Uppada, chinna alivi is the most efficient gear for prawns, though it is operated seasonally.

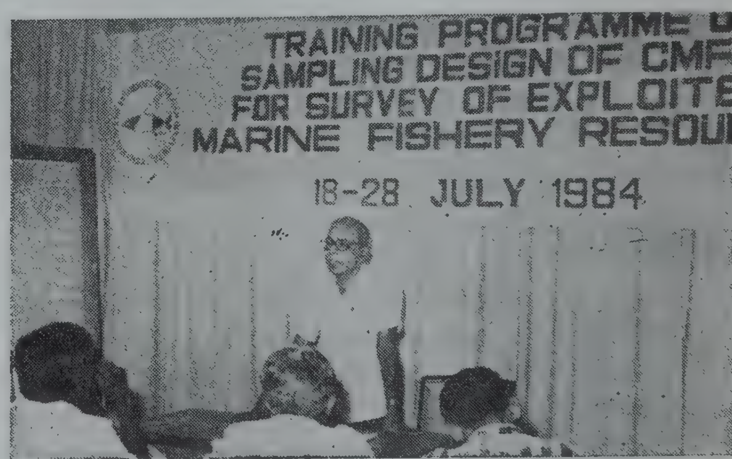
The author express her gratitude to Dr. M.J. George, for suggesting improvements. Assistance rendered by Shri J. B. Varma, T–1, is gratefully acknowledged.



TRAINING PROGRAMME ON SAMPLING DESIGN OF CMFRI FOR SURVEY OF EXPLOITED FISHERY RESOURCES*

Realising the potentialities of marine fishery sector in the national growth, Government of India established the Central Marine Fisheries Research Institute as early as in 1947. Since then this Institute is collecting marine fish catch statistics and other data on biological and environmental parameters as these data are required for understanding the conditions of the exploited fish stocks. Basing on its vast experience in the field of collection of marine fish catch statistics and the information obtained through pilot surveys conducted by the Indian Council of Agricultural Research during the fifties, the CMFRI has developed for this purpose a stratified multistage random sampling design.

The need for regionwise estimates for planning and development in the states was felt and the state governments have started collecting data on marine fish landings on regionwise basis to meet their plan requirements. The design of sampling for and the methods of collection of marine fish catch statistics differ from state to state. Cognising the importance of obtaining precise catch statistics for rational development and management of fishery sector a meeting of the chief ministers and ministers for fisheries of states and union territories was held in Hyderabad during 25–26 June 1983 and was presided over by the Hon'ble Minister for Agriculture and Co-operation, Government of India. In order to standardise the sampling method and streamline the process of collection of marine fish landings in India it was suggested in that meeting that the CMFRI, Cochin should arrange for training for the officials of state departments and U.Ts on the method of collection of



'To err is human'—a class on ways and means to reduce non sampling errors in session.

* Prepared by Fisheries Resources Assessment Division, C.M.F.R.I., Cochin.

marine fish catch statistics as developed by the Institute.

Accordingly the first training programme was organised by the CMFRI in Cochin during 18–28 July 1984 and there were 20 participants representing various states and UTs. In this programme basic theory on sampling with practicals was included so as to give an insight to the trainees on the importance of sampling on scientific basis for estimation of marine fish landings. The trainees were also exposed to field experience in the actual collection of data by arranging their visits to Fisheries Harbour in Cochin and other fish landing centres. In addition, training in the preparation of field programmes, filling up of schedules and estimation of fish landings was also given to them.

On 18–7–'84, in his inaugural address Dr. E.G. Silas, the Director, CMFRI, explained the purpose for which the training was arranged, the necessity for obtaining precise catch estimates for planning and developmental purpose and the importance of having a unified system of collection of catch statistics on a sound scientific basis. Wishing all success for this programme he expressed the hope that this ten day comprehensive training programme would go a long way in meeting the requirements for which it has been organised. In the afternoon to acquaint the trainees on the various aspects of research projects of CMFRI, lectures by Heads of the Divisions of this Institute were arranged. Dr. K. Alagarswamy, Head, Molluscan Fisheries Division, Dr. P. V. Ramachandran Nair, Head, Fishery Environment Management Division, Dr. P. V. Rao, Head, Physiology, Nutrition and Pathology Division and in-charge of Centre of Advanced Studies in Mariculture and Shri M. S. Muthu, Scientist in-charge, Narakkal Prawn Culture Laboratory explained the work done under various projects in their respective Divisions. During 19–23 July '84 lectures on basic theory of sampling with practicals were arranged. Three days were devoted to visit fish landing centres for the collection of data on marine fish landings. On 27–7–'84 the data collected by the trainess were taken up for processing and analysis. On 28–7–'84 general discussions were held so as to exchange ideas to improve the system of data collection and to clear doubts if any of the trainees.

The valedictory function was arranged in the afternoon of 28–7–'84. After the welcome speech by Dr. K. Alagaraja, Scientist, CMFRI, the Chairman Dr. E. G. Silas in his remarks expressed the hope that the knowledge gained by the trainees would be made use of in their respective states so as to improve the method of collection of marine fish catch statistics, and the purpose of the training to have a uniform method of collection of marine fish catch statistics on a sound scientific basis would be served. In his valedictory address, the chief guest Shri. K. M. Chandrasekhar, I.A.S. Director of Fisheries, Government of Kerala mentioned the importance of statistical sampling for planning and development purposes. Estimates, for short time intervals, were required for timely action particularly in the case of fisheries. Appreciating the work done by the CMFRI he indicated that more and more information were required to fill some of the gaps in the fishery statistics. While concluding he expressed his hope that this training programme would lead to improving the method of collection of catch statistics in the states and UTs and maintaining the good liaison between the scientists of CMFRI and the officials of state governments and UTs. The function came to a close with vote of thanks by Shri S. K. Dharmaraja, Scientist, CMFRI.

The schedule of the Training programme containing the topics and names of faculty members is appended. Lecture notes by the faculty members have been distributed to the trainees. The list of the names of the trainees is also appended. The statewise breakup of nominees is as follows.

	State and Department	No. of nominess
1.	West Bengal, Department of Fisheries	1
2.	Andhra Pradesh, Commissionerate of Fisheries	2
3.	Tamil Nadu, Department of Statistics	1
4.	Pondicherry, Department of Fisheries	6
5.	Kerala, Department of Fisheries	1
6.	Goa, Department of Fisheries	2
7.	Maharashtra, Department of Fisheries	2
8.	Gujarat, Commissionerate of Fisheries	2
9.	Andamans & Nicobar Islands, Department of Fisheries	2
10.	Lakshadweep and Minicoy Islands, Department of Fisheries	1
	Total	20

Training on Sampling Scheme adopted by the Central Marine Fisheries Research Institute, Cochin for the state department Personnel.

Date	Time (hrs)	Topic and members of faculty
18–7–'84	10.00	Registration.
	10.30	Inauguration.
	14.00–16.00	Highlighting the research programmes of the Institute by the Heads of Divisions.
19–7–'84	10.00–13.00	Introduction to sampling covering the items: need for sampling – units - population – frame – census vs sampling - random vs purposive sampling etc. Shri K. S. Scariah, Scientist S1.
	14.00–16.00	Simple random sampling – with and without replacement – its properties – selection of units – random numbers – estimation. Shri M. Srinath, Scientist S1.
20–7–'84	10.00–13.00	Cluster sampling and systematic sampling – their advantages and disadvantages – examples Shri. K. Balan, Scientist S1.
	14.00–16.00	Stratified sampling and methods of estimation with suitable examples. Shri. K. Narayana Kurup, Scientist S1.
21–7–'84	10.00–13.00	Multistage sampling and the sampling design of C.M.F.R.I. for collection of marine fish catch statistics. ICAR pilot surveys – uses of the data. Dr. K. Alagaraja, Scientist S2.
	14.00–16.00	Preparation of work programmes–schedules used – uses of random number tables supplied. Shri S. K. Dharmaraja, Scientist S2.
23–7–'84	10.00–13.00	Non sampling errors– sources of errors– ways and means to reduce them to the minimum. Shri T. Jacob, Scientist S3.
	14.00–16.00	Sampling designs followed by various state governments. The participants & Dr. K. Alagaraja, Scientist S2.
24–7–'84 to 26–7–'84		Visits to landing centres/Cochin Fisheries Harbour – collection of data in the prescribed schedules covering both mechanised and non-mechanised units. S/Shri G. Balakrishnan, Field Officer (T.6), U.K. Sathyavan, Field Officer (T6), Varghese Philipose, Field Officer (T5), K. C. Yohannan, Sr. Technical Assistant, (T.4), P. Karunakaran Nair, Sr. Technical Assistant (T. 4) and Joseph Andrews, Technical Assistant [T. 1(3)].
27–7–'84		Processing – analysis– estimation – comparison of estimates. S/Shri K. N. Kurup, K. Balan, M. Srinath

		and K. S. Scariah Scientist (S1) and Technical staff of the Divn.
28–7–'84	10.00–13.00	Discussions on various items of sampling – organisation and collection of marine fish catch statistics – adopting uniform procedure -- all scientists.
	14.00	Valedictory function.

List of participants for the training programme on sampling design for collecting fish catch statistics 18-28 July 1984

1. Shri A. R. Abdul Guddoose, Inspector of Fisheries, Department of Fisheries, Pondicherry.
2. Shri S. D. Adarkar, Statistical Inspector, Department of Fisheries, Maharashtra.
3. Shri S. Q. Ahmed, Sr. Investigator, Office of the Commissioner of Fisheries, Andhra Pradesh.
4. Shri M. Amanullah, Statistical Inspector, Department of Statistics, Tamil Nadu.
5. Shri R. Appaji, Sub-Inspector of Fisheries, Department of Fisheries, Pondicherry.
6. Shri D. P. Bhise, Research Assistant, Directorate of Fisheries, Goa.
7. Shri A. Bhopal, Inspector of Fisheries, Department of Fisheries, Pondicherry.
8. Shri J. Chandrasekhar, Assistant Fisheries Development Officer, Andamans.
9. Shri P. M. Dixit, Assistant Statistician, Department of Fisheries, Maharashtra.
10. Shri A. M. Joseph, Research Officer (Statistics), Directorate of Fisheries, Kerala.
11. Shri K. Koya, Statistical Assistant, Directorate of Fisheries, Lakshadweep.
12. Shri G. C. Nedurmath, Assistant Superintendent of Fisheries, Directorate of Fisheries, Goa.
13. Shri I. C. Parekh, Fisheries Officer (Statistics), Gujarat State Fisheries.
14. Shri K. S. Prajapati, Fisheries Officer (Statistics), Gujarat State Fisheries.
15. Shri E. K. Raveendran, Fisheries Development Officer, Directorate of Fisheries, Andamans.
16. Shri X. A. Roche, Inspector of Fisheries, Department of Fisheries, Pondicherry.
17. Shri Shyamal Kumar Sengupta, Supervisor, (Field-cum-Computation), Directorate of Fisheries, West Bengal.
18. Shri C. Subbarao, Statistical Officer, Office of the Commissioner of Fisheries, Andhra Pradesh.
19. Shri K.Suryanarayana Raju, Inspector of Fisheries, Department of Fisheries, Pondicherry.
20. Shri K. K. Vijayaraghavan, Inspector of Fisheries, Department of Fisheries, Pondicherry.

MASS MORTALITY OF CATFISHES AND OTHER BOTTOM FAUNA AT PUDIAPPA, CALICUT*

The sea off Calicut suddenly became rough on 7th April 1984 and severe wind, high waves and strong breakers flooded the coastal areas between Pudiappa and Beypore. The high breakers at several places crossed the narrow sand bar that divide the sea from the low lying areas and flooded many thickly populated pockets along the Calicut coast. Towards evening, breaches occurred along the sand bar and long stretches of low lying areas between Pudiappa and Marad, extending to about 15 km, were submerged in sea water. The wave height at certain places rose up to 2 to 2.5 meters and the rough condition of the sea prevailed till 9th April.

*Prepared by N. Gopinatha Menon and C. V. Mathew, Calicut Research Centre of C.M.F.R.I., Calicut.

Mass morality of fishes at Pudiappa

Along the coast of Calicut, Pudiappa is a semi-protected calm bay area. During the days when rough sea conditions prevailed the flow of water was from south to north. Along with this northward flow of water, probably the churned up bottom sediments in the shallow regions also would have shifted towards north and got accumulated in the semi-protected Pudiappa bay. This observation was further substantiated by the lack of any mud formation north of Pudiappa. Thus, there was a total churning up of the bottom mud in the bay consequent on high waves, strong breakers and an influx of mud from south. In the morning of 8th

TABLE 1

Station	Temp. (°C)	0_2 (ml/l)	Sal. (‰)	PO_4	NO_2	NO_3	SiO_3
					(μ gram atom/l)		
Date: 9–4–1984				Condition of the sea: Rough and turbulent			
1. Pudiappa	35.8	0.73	33.81	10.57	0.47	4.93	52.63
2. Kothi beach	34.1	4.68	32.92	6.00	0.08	3.00	26.31
3. Marad beach	32.2	5.18	32.64	0.32	1.30	3.60	13.15
Date: 5–4–1984				Condition of the sea: Calm			
4. West Hill	31.0	4.69	33.14	1.33	0.02	1.65	8.55

Fig. 1. The sunken boats (manchi) at Pudiappa in the mud flat (Fore g round: bags of rice washed ashore).

Fig. 3. Dead and decaying catfishes remained at the beach after the devastation.

Fig. 2. Mass mortality of catfishes at Pudiappa.

Fig. 4. Large pallets of mud washed ashore when the bay became calm.

April the thick muddy water of Pudiappa was virtually teeming with thousands of fishes gasping for breath. The waves washed huge quantities of fishes and mud to the shore. Within a short time the whole of Pudiappa beach, extending to about 3–4 ha, was carpeted by fishes and loose mud. Along with fishes, huge quantities of bivalves and gastropods were also washed ashore. It was found that more than 90% of the fishes washed ashore were catfishes of a single species, *Tachysurus maculatus*. Other fishes suffered mortality were sciaenids, soles, eels, platycephalids, *Squila* sp. and prawns. Roughly it was estimated that about 15 tonnes of fishes suffered mortality. The catfishes were in the size range of 92 to 338 mm in total length. Analysis of fish samples showed that the gills were completely clogged with soft mud and in many cases mud was found in the stomachs. The large scale mortality suffered by catfishes indicated their behaviour pattern and their aggregation in the bay. *T. maculatus* which is essentially an estuarine catfish, also occur along shallow coastal waters and seldom move beyond 10 to 15 meters in depth. Since the species is a scavenger, large shoals congregate in fishing harbours and coastal fish landing areas where more food is available. And as such, Pudiappa is a nourishing ground for these fishes. The sudden influx of mud together with the churning up process would have made the water of Pudiappa turbid and thereby reducing the oxygen content of the water to sub-lethal level. Thus, asphyxiation seemed to be the causasive factor for the sudden large scale mortality of the fishes.

For Pudiappa villagers 8th April morning gave rich catches of fishes without much effort. The asphyxiated fishes were hand picked from the surf. Since there was no fishing on 7th and 8th the fishes washed ashore found a good market and as such truck loads of catfishes were taken to various markets.

For a study on the physico-chemical characters of the turbulent sea, water samples were collected from three stations, Pudiappa, Kothi and Marad beach on 9th April. Eventhough there were no mass mortality or mud formation at the latter two stations, these areas were also seriously affected in the calamity and hence selected for the study. Analysis of the turbid water of Pudiappa showed that the concentration of find mud in the sea water was 38.2% by volume. The sea water samples from all the stations were analysed for salinity, dissolved oxygen, phosphate, nitrite, nitrate and silicate and the values are given in Table 1 along with the values from West Hill on 5th April for a comparative study.

The very low values of dissolved oxygen and very high values of silicate and phosphate of the affected waters compared to the unaffected waters give clean evidence to the condition that led to the mass mortality of fishes at Pudiappa. However, the actual cause of the sudden changes in the coastal areas remains enigmatic. A detailed study of such phenomena when they do occur would help in understanding the oceanographic processes associated with them.

RECOVERY OF A RINGED SANDWICH TERN, *STERNA SANDVICENSIS SANDVICENSIS* FROM RAMESWARAM ISLAND*

The sandwich tern *Sterna s. sandvicensis* Latham, which is known to perform intercontinental wintering migration has been known to frequent Sind and Makran Coast (Ali and Ripley, Handbook of the Birds of India and Pakistan, 3:1-70, 1981) and Sri Lanka Coast (*Ceylon Bird Club Newsletter, Sept.*, 1978). In India the bird has been sight recorded from Saurashtra (Dharakumarsinghji, *Bombay Nat. Hist. Soc.*, **55**: 357, 1958).

On 19–9–1983 one specimen of the sandwich tern was recovered from Kundukal point of Rameswaram Island (Fig. 1) with a metalic ring having a Russian inscription and a number P.702628 on it. The bird (Fig.2) which is locally known as *Katrenji* in Tamil had the following salient features.

Crown black; a black stripe continues from the eye back to the crown; body ash coloured dorsally, white ventrally; bill long, slender, tipped with yellow; foot webbed and primaries black.

*Prepared by R. S. Lal Mohan, Regional Centre of C.M.F.R.I., Mandapam.

Table 1. *Details of the sandwich tern caught in India*

Sl. No.	Bill (mm)	Tarsus (mm)	Locality	Date	Remarks
1.	52	26	Pillaimadam lagoon, Mandapam	24–6–1983	Without ring
2.	50	25	Kundukal point, Rameswaram Island	19–9–1983	With ring
3.	45	25	Pillaimadam lagoon, Mandapam	7–11–1983	Without ring

Fig. 1. *Sterna sandvicensis sandvicensis* with the ring from Rameswaram Island.

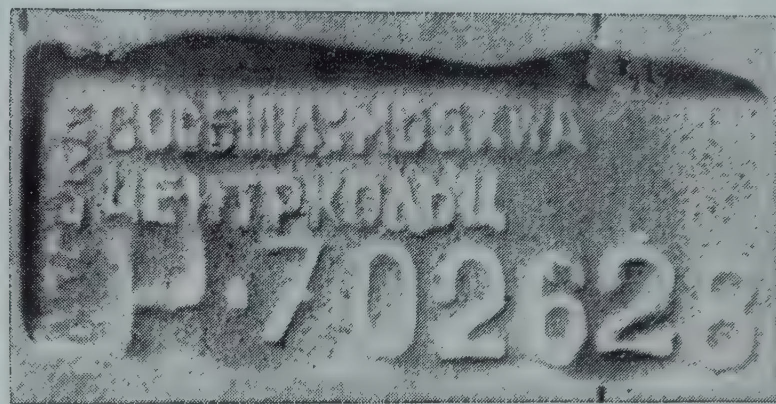


Fig. 2. The metallic ring with Russian inscription recovered from the sandwich tern (Length of the ring 18 mm).

The ring (Fig. 2) suggests that the bird was ringed in Russia. It may be mentioned that two other birds of same species were also recovered from the Pillaimadam Lagoon near Mandapam which indicates that the bird is a common visitor to these areas. They were found along with other common terns namely *Hyderoprogne caspia* (Caspian tern), *Sterna aurentia* and *Gelochelidon nilotica*. The details of the birds recovered are given in Table 1.

There has been record of recovery of the Sandwich tern from Kalpitiya, Sri Lanka on 24–12–1977 which was ringed at Astrakhan Reserve, Caspian Sea, Russia *(Ceylon Bird Club Newsletter,* 1979).

The present capture of the sandwich tern from Rameswaram area in June is of special interest as it is much earlier than its usual arrival in Sri Lanka coast which is around December. The species is known to breed in British Islands, North sea Islands, Atlantic and Mediterranean coasts of Europe, Black Sea and Caspian Sea. It winters on the coasts of Northern Africa, Western Africa to Cape of Good Hope, Red Sea, Persian Gulf, Makran and Sind coast and Sri Lanka. Its wintering area now includes Southeast coast of India including Rameswaram island.

Compiled and prepared by Dr. M. J. George, Dr. K. J. Mathew, Mr. G. Nandakumar & Miss Jancy Jacob
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MARINE FISHERIES INFORMATION SERVICE

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Technical and Extension Series

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

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THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the National Marine Living Resources Data Centre (NMLRDC) and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

Abbreviation – *Mar. Fish. Infor. Serv. T & E Ser.*, No. 63: 1985

CONTENTS

Front cover photo: The Indian mackerel *Rastrelliger kanagurtta*
Back cover photo: A bumper catch of mackerel landed in Cochin

THE MACKEREL FISHERY — A SHORT REVIEW

A. Noble
Central Marine Fisheries Research Institute, Cochin

Trends in production

Estimated landings of mackerel in India is available from 1950 to 1982 in published accounts (CMFRI, 1969, 1980, 1982, and 1983). The data for 1983 is taken from the reports and records of Fishery Resources Assessment Division of the Central Marine Fisheries Research Institute. Ranging between 16,431 tonnes of 1956 and 2,04,575 tonnes of 1971 (Fig.1), the landings fluctuated widely from year to year.

Though the fish is available all along the Indian coasts, it forms a commercial fishery in the west from Quilon in Kerala to Ratnagiri in Maharashtra only. In 1965–'83 (full complements of statewise landings including that of the Union Territory of Goa being available from 1965 onwards only), the catches in Kerala ranged between 3,600 tonnes of 1968 and 95,164 tonnes

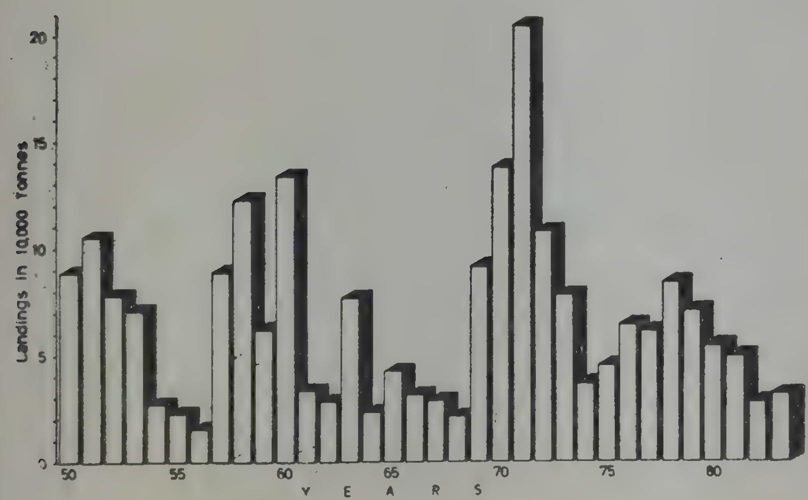

Fig. 1. Annual mackerel landings in India.

of 1971 (Fig. 2). The catches, nevertheless were mostly between 10,000 and 20,000 tonnes. In Karnataka, in 19 years, the catches fluctuated from 2,182 tonnes of 1983 to 64,047 tonnes in 1971. The landings here were erratic during 1965 to 1969. Subsequently it increased to almost above 20,000 tonnes per year, except 1974 and 1975, and 1982 and 1983 (Fig. 2).

Goa is the next important place of mackerel production in the country. The catches here varied between 220 tonnes of 1983 and 35,258 tonnes of 1971 (Fig. 2). In fact, the catch here was never as low as it occurred in 1983. Prior to it, the lowest was 2,446 tonnes of 1980; and production from 3,5C0 to 8,CC0 tonnes per annum was most common. In Maharashtra (Fig. 2), the catches oscillated widely between four tonnes of 1967 and 20,683 tonnes of 1969. The catches here, however, were mostly below 25,C0 tonnes only. The annual mackerel landings swung between 0 and 112 tonnes in Gujarat, 13 and 2,015 tonnes in Orissa, 1,040 and 6,525 tonnes in Andhra Pradesh, 521 and 12,086 tonnes in Tamil Nadu–Pondicherry, and 12 and 348 tonnes in Andaman & Nicobar Islands (Fig. 2). However, the catches were generally confined to 2,CC0 to 5,000 tonnes in Tamil Nadu–Pondicherry and it varied between 1,000 and 3,000 tonnes in Andhra Pradesh. In Orissa, the catch touched four digits in 1983 after 12 years of such an occurrence in 1970.

The all-India average annual landing of the mackerel in 34 years of 1950–'83 period was 66,584 tonnes. The catches during 1950–'53, 1957–'60 (except 1959), 1963, 1969–'73 and 1978–'79 (Fig. 3) were higher than this and lower for the rest. The average all-India annual value computed for 19-year period of 1965–'83 when statewise landings in full are available, is 67,419 tonnes. Average annual production of mackerel during 1965–'83 period was 8,542 tonnes along the east coast and 58,877 tonnes on the west coast. The 19-year averages in the states were; Karnataka 23,478 tonnes, Kerala 23,094 tonnes, Goa 9,001 tonnes, Tamil Nadu–Pondicherry 5,321 tonnes, Maharashtra 3,293 tonnes, Andhra Pradesh 2,688 tonnes, Orissa 436 tonnes, Andaman & Nicobar Islands 97 tonnes, and Gujarat just 11 tonnes.

For the first time in the history of mackerel fishery, seven tonnes of it is reported to have occurred in the fish landings of Bengal in 1983. The mackerel landings in east coast in the year exceeded the landings of west

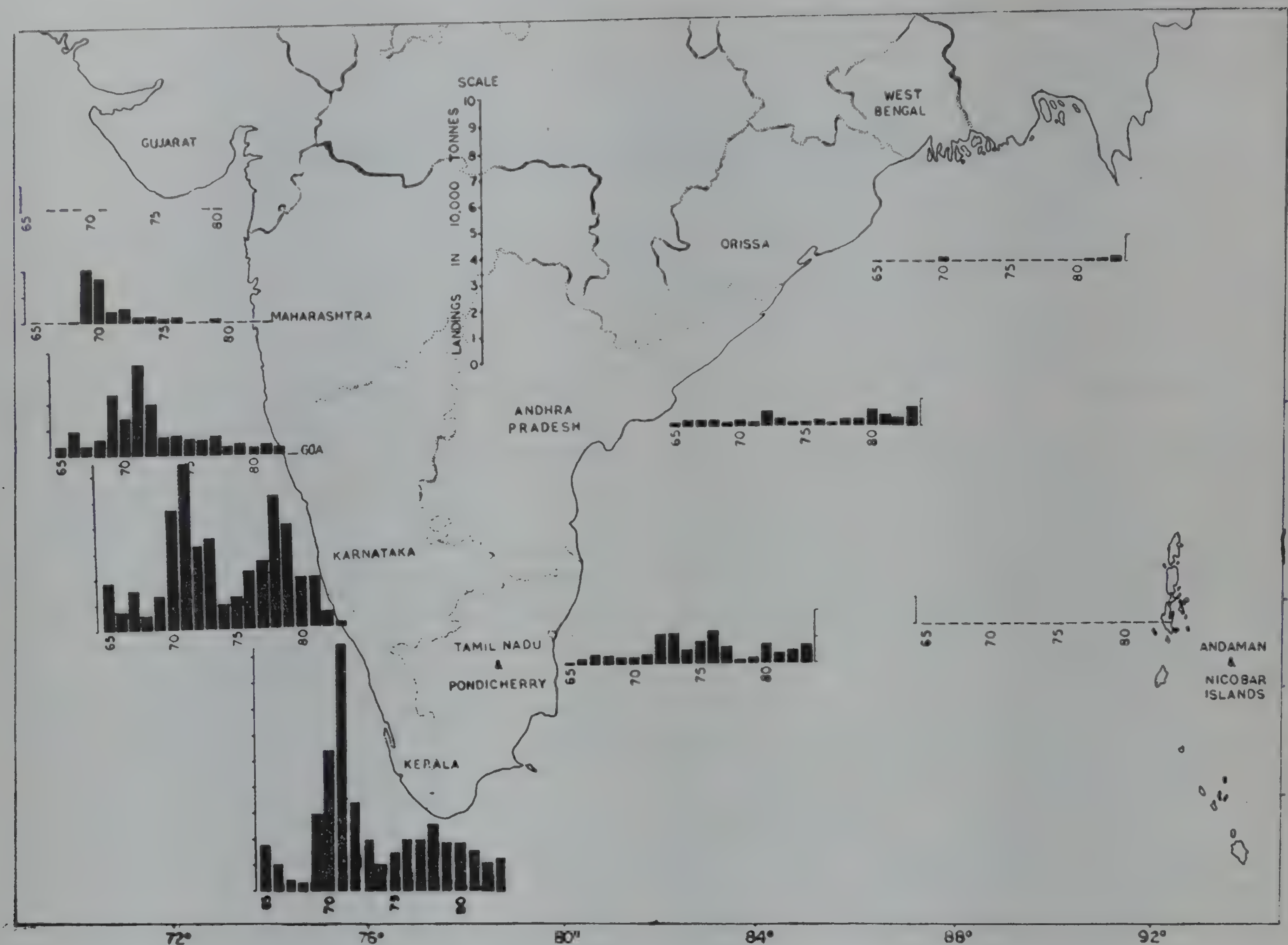

Fig. 2. Statewise mackerel landings during 1965–'83.

coast, also for the first time, with 15,680 and 15,503 tonnes (Fig. 4) forming 50.3 and 49.7% respectively. The percentage contribution from east coast in the previous year also was as high as 31.8. The mackerel production in east coast in 19 years (Fig. 4) shows the

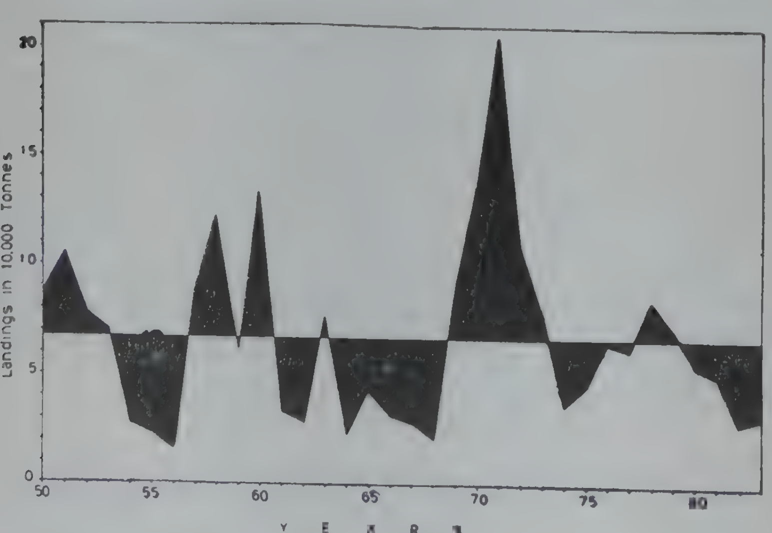

Fig. 3. Fluctuation of all-India annual mackerel production from average landing during 1950–'83.

catches to vary between 2,233 tonnes of 1965 and 16,700 tonnes of 1972. In 1972 when the landing was the highest here in quantity, it formed only 15.3% in the all-India catch. Along the west coast, the catches varied between 15,503 tonnes of 1983 and 1,99,120 tonnes of 1971. The contribution from west coast, however, was 97.3% in 1971 forming the highest percentage in record. Another year of low production in west coast was 1968 with 16,123 tonnes. But it formed 74.3% in country's catch of the year.

During 1965–'83, Karnataka tops with 34.82% (Fig. 5) of the total mackerel production in the country. Kerala closely elbows it with 34.25%. The contribution of Goa in all-India production is 13.35%. States next in order of importance are Tamil Nadu-Pondicherry, Maharashtra, Andhra, Orissa, Andaman & Nicobar Islands and Gujarat; contributing to 7.89%, 4.89% 3.99%, 0.65%, 0.14% and 0.02% of the total catches respectively.

Contribution of mackerel in marine fish production in the country from year to year is given in Fig. 6, and

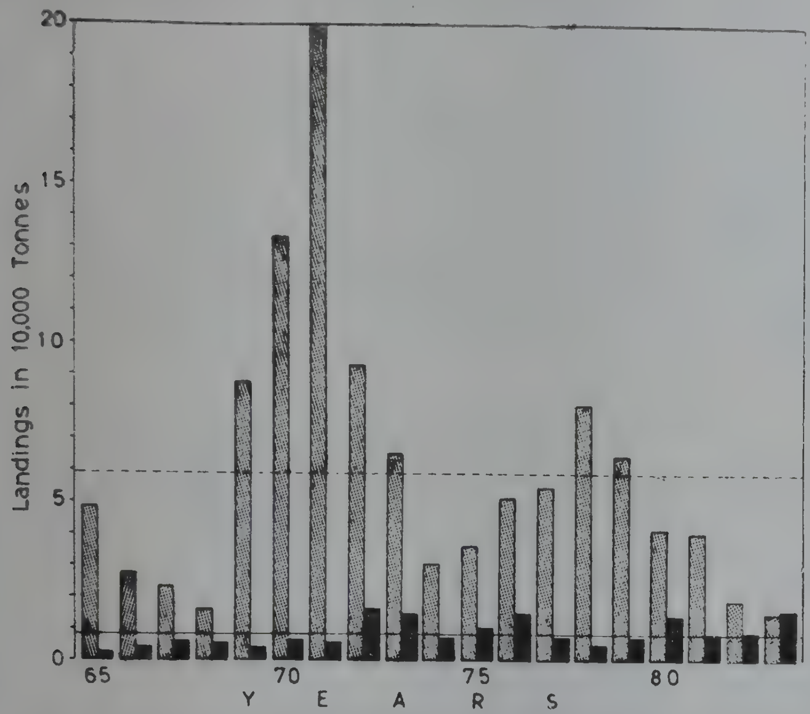

Fig. 4. Annual landings of mackerel in east coast (black bars) and west coast (stippled). The continuous line shows 19-year average in east coast and broken line depicts it in the west coast.

the production of mackerel is not in proportionate pace with the increase in marine fish production. The average annual production of marine fish during 1950–'83 was 958,178 tonnes and mackerel in it formed 66,584 tonnes.

The mackerel contributed to a percentage as high as 19.65 in the total marine fish production in the country in 1951. However, in 1971 when the mackerel catch was the highest, it formed only 17.61% in the year's marine fish landings. During the 10-year period commencing with 1973, the percentage of mackerel in the marine fish catches was low (Fig. 7). Earlier for 8 years starting from 1961 (except 1963) and 3 years beginning with 1954, the percentage of mackerel in the marine fish catches was low. The lowest ever recorded percentage of 1.97 occurred in 1982. The percentage, in fact was 2.29 in 1956 when the catch was the lowest.

The percentage of mackerel in the marine fish catches during 1950–'83 as a whole was 6.95. But on account of persistent low values in recent past, as detailed above, the average percentage in 1965–'83 reduced to 5.69 (Fig. 8).

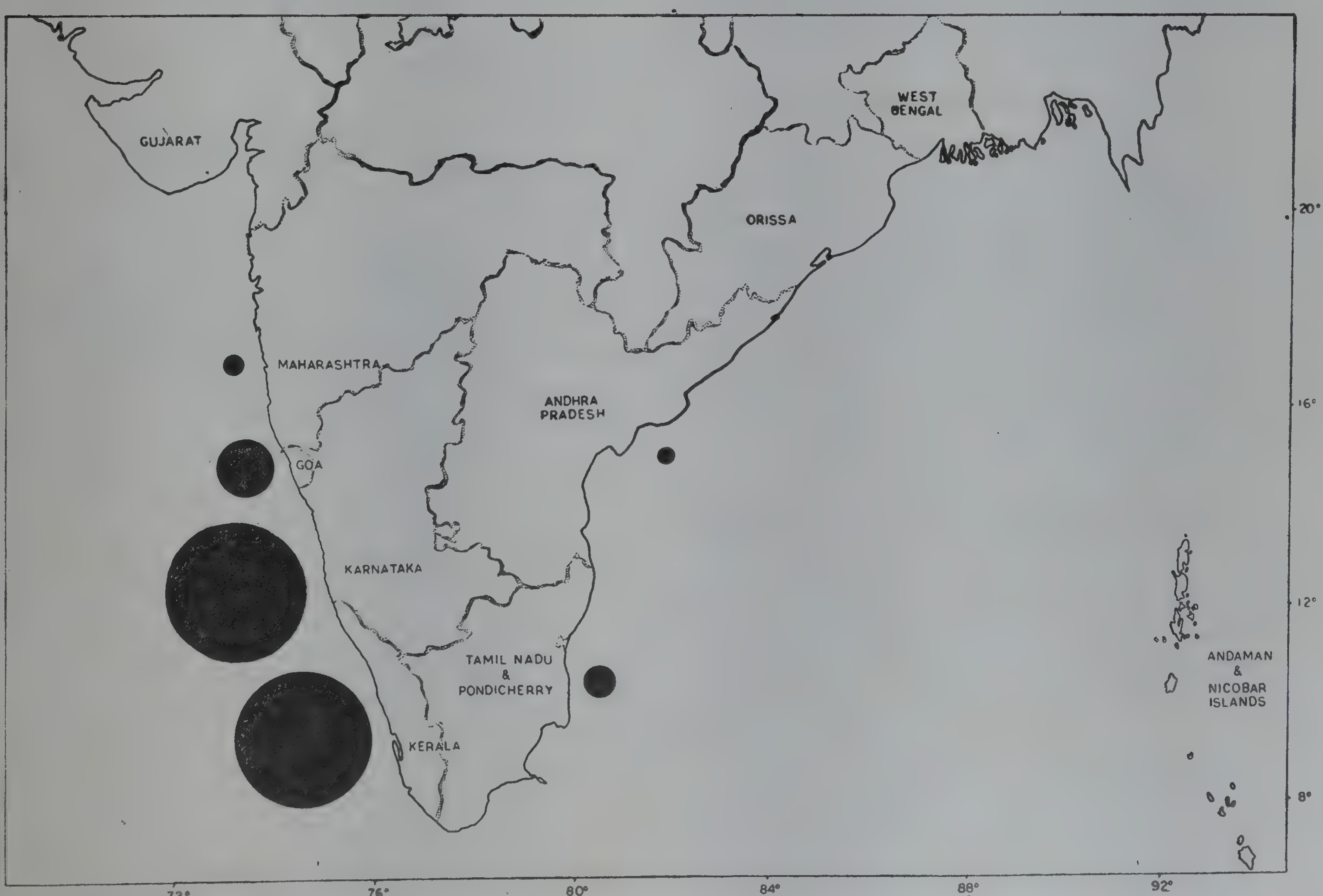

Fig. 5. Percentage of mackerel production by states in the all-India total catch.

The importance of mackerel in the economy of Goa is high as it forms 34.38% in the marine fish catches there during 1965–'83 (Fig. 8). The contribution of mackerel to the total marine fish catches in Karnataka is 23.21%. Mackerel is the only fish that can be claimed as proprietary item of these states in the country.

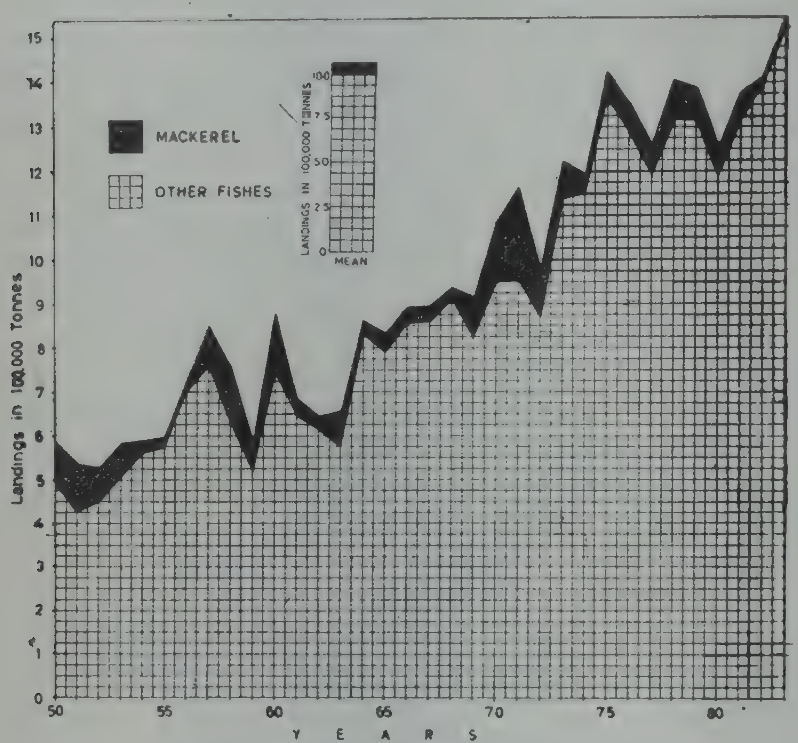

Fig. 6. Mackerel in annual all-India marine fish catches.

In spite of high catches, mackerel in Kerala forms only 6.49% in its marine fish landings (Fig. 8). Huge catches of oil sardine here cause such a situation. In Andaman and Nicobar Islands, the catch of mackerel, though very little in quantity, is worth mentioning as it forms 7.68% (Fig. 8) in the marine fish catch. In other maritime states of the mainland the percentage of mackerel in their marine fish landings is 2.68, 2.62, 1.51, 1.13, and 0.01 respectively in Tamil Nadu-Pondicherry, Andhra Pradesh, Maharashtra, Orissa, and Gujarat.

The mackerel season in the country falls during September–April period (Noble, 1982 a). As the bulk of the landings occurs along the west coast the seasonal distribution on all-India level is only a reflection of what is happening in the west. The fishery, here commences first in the south and late in the north (Noble, 1979). It often peaks in Kerala in September itself. In Karnataka and Goa, though the season commences in September, intense landings occur in October. In Maharashtra, on the other hand, the season commences in October but peaks in November. The peak landing also thus occurs earlier in the south than in the north (Noble, 1979). In the east coast of the mainland, nevertheless the maximum occurs in March–April. But in Andaman & Nicobar Islands, the season is a protracted one the mackerel occurring almost equally in all the months of the year (Noble, 1982 a).

Rastrelliger kanagurta is the species that commercially contribute to the fishery in the country. *R. brachysoma* and *R. faughni* also occur in our waters. The mackerel landed in 1981 and 1982, for instance in Tamil Nadu-Pondicherry consisted of respectively 0.57% and 0.14% species other than *R. kanagurta* (CMFRI, 1982 and 1983).

Mackerels were once caught only in boat seines, shore seines and gill nets operated from indigenous fishing crafts. Of late, mechanised units like purse seines, drift nets and trawls also exploit this resource especially along the west coast. In fact, the purse seine has virtually replaced the indigenous gear in Karnataka and Goa where 78.7% and 90.6% respectively (Fig. 9) of the catch in 1981 were landed by mechanised units (CMFRI, 1982). In Kerala, 75.0% of the catches in the year was still made by indigenous fishing units only. Exploitation of mackerel by mechanised units increased here also in the subsequent year (CMFRI, 1983).

Research high-lights

Advent of mechanised fishing and resultant expansion of fishing grounds, however, have not concurrently improved the landings in the country as a whole and Karnataka in particular. In 1956, when the mackerel catch was the lowest the catch in Karnataka with *Rampani* as principal gear in vogue was 3,177 tonnes (CMFRI, 1969). But with about 400 purse seiners working along Karnataka coast at present, the mackerel catch crumbled to just a low value of 2,182 tonnes in 1983. The highest catch since 1950 in Karnataka was 81,882 tonnes of 1960. In 1957 and 1958 also, when

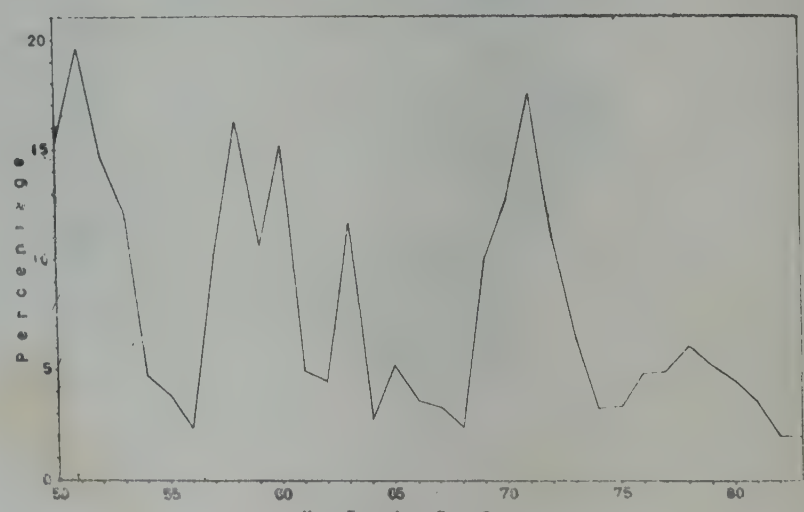

Fig. 7. Percentage of mackerel in annual marine fish production.

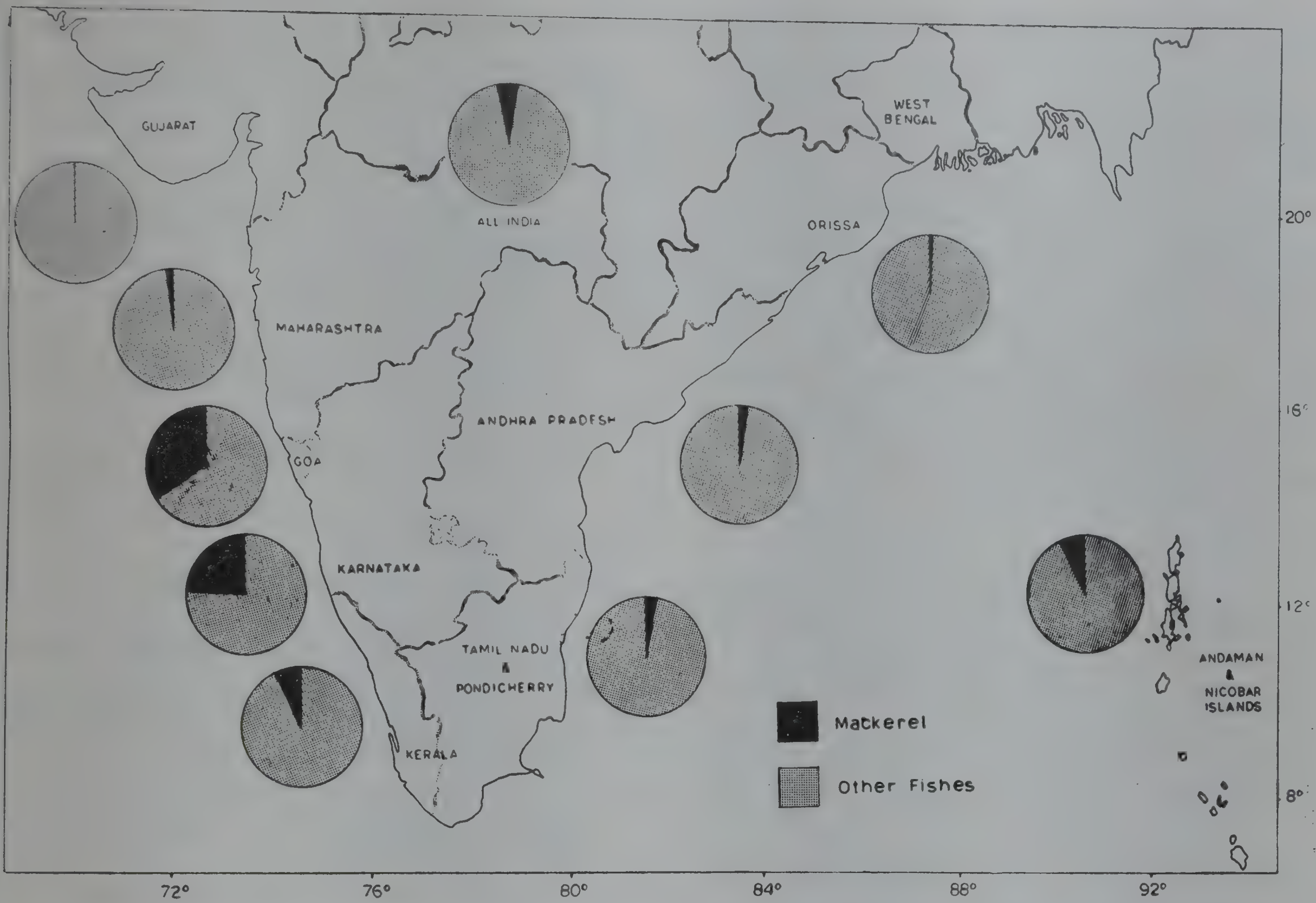

Fig. 8. Percentage of mackerel in marine fish landings of different states, and country as a whole during 1965–'83.

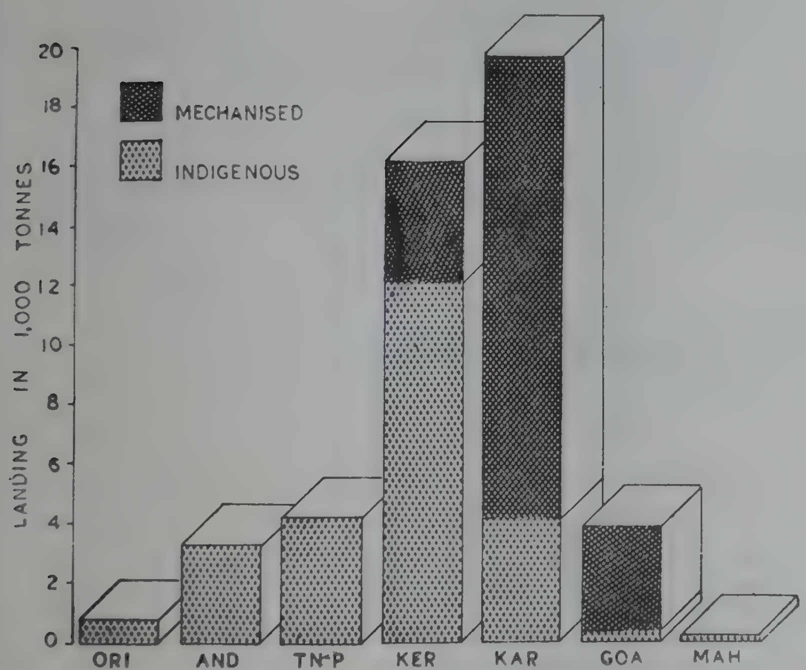

Fig. 9. Statewise landing of mackerel by mechanised and non-mechanised gear in 1981.

Rampani was the gear in command, the catches were as high as 55,754 and 63,365 tonnes respectively (CMFRI, 1969). Since introduction of purse seine in late nineteen seventies, the highest annual catch was only 50,704 tonnes of 1979. The story in Kerala and Goa is also in no way different. The fishery in its 10-year cycle of long term fluctuations (Noble, 1980) presently is on a low ebb, and to crown it, mature fish and spawners seem to be disturbed by the mechanised fishing fleet (Noble, 1982 b).

As already stated, the mackerel fishery in its long term fluctuations shows a 10-year cycle with ups and downs (Noble, 1980), and the current trend, notwithstanding is not encouraging. Whether it is caused by human interference and intrusion into their nurseries or due to fishery independent environmental factors is a matter of much concern. Suspension of fishing by purse seine during June–August, coinciding the supposed spawning period of the fish, however, is a great relief.

The annual stock of mackerel as estimated by Sekharan (1974) is 1,30,000 tonnes. The average production in ninteen seventies being 92,000 tonnes indicated an exploitation around 70% of the stock. The total mortality declaring the death of 94% of stock, in

these years was 2.877 (Noble, MS). The fishing mortality (total mortality less natural mortality of 0.9 by Sekharan 1974) is 1.977 and the rate of exploitation becomes 68.7%. Banerji (1973) also computes a rate of 68.3% exploitation for earlier years.

Investigations on the age composition of the commercial catches through length frequency studies reveal the fishery to sustain mainly on a single year class recruited afresh every year. The commercial fishery depends chiefly on fish of sizes 16 to 23 cm in total length. For want of non-selective specific gear a reliable index of its abundance in the sea is, however, lacking; rendering estimates on mortality, stock assessment and exploitation rates a little difficult.

Prospects

Monitoring resource characteristics on the mackerel at present is being carried out when they are already recruited and commercially being exploited. By and large, it imparts some data on the resource and availability of spawners. It is imperative at this juncture to conduct fecundity studies, spawning surveys, eggs and larval studies, young fish surveys, and recruitment studies; involving sophisticated acoustic and aerial devices and remote sensing through satellites. The erstwhile Pelagic Fishery Project at Cochin had done some work on this line for a few years (PFP, 1974) along the southwest coast bringing out quantitative appraisal of the resource ready for recruitment shortly after. Besides, such a study imparts also advance information on the movement of stock and their direction indicating when and where they hit the coast. Fixing up a national target of production is then a feasible proposition, accordingly aiding regulation of annual exploitation avoiding over-fishing and depletion of stock.

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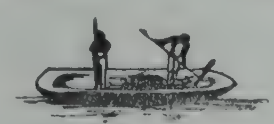

MARINE FISHERY OF WEST BENGAL COAST*

Introduction

West Bengal has a coastline of 120 km spread over the districts of Midnapur and 24 Parganas lying on either side of the mouth of river Hooghly. Marine fisheries here up to fifties were confined to the operation of a few bag nets, shore seines, stake nets and some seine nets. The fishing activities continued for three months in a year from mid-October to middle of January. Fishermen from erstwhile East Pakistan settled in Musidabad and Naidia districts introduced monofilament drift nets in the sixties, and revolutionised the fishing industry. Consequently the fishing season extended from July to March and fishermen belonging to Hooghly and Howrah also started fishing in sea. Mechanisation of countrycrafts with bag nets, drift nets and seine nets followed in seventies and boosted the catch, and people of many other community also came into the fray. Trawling is not yet in vogue, although trawlers based at Vishakhapatnam regularly fish in this coast.

*Prepared by S.S. Dan, Field centre of CMFRI, Contai, W.Bengal.

Fishing bases and landing centres

There are only a few marine fishing villages along West Bengal coast. Fishermen from interior villages, however, come down during season time to coastal areas and establish temporary fishing bases. About eight such bases namely Disha, Jadha, Kharpai and Junput in Midnapur District, and Frazergunj, Bakkhali, Jamboo and Handi Bhanga in 24 Parganas District are usually formed. Normally landings take place in these bases. Apart from them, landings occur at Fatta, Diamond Harbour, Kakdwip and Nambhana in 24 Parganas District. Catches from fishing grounds are transported by mechanised carrier boats and landed.

Fishing crafts

Clinker built boat called *Patia* or *Paukhia* without deck are used for operating shore seine and drift nets and carved built boats called *Salti* with deck made of bamboo splits are used in the operation of bag nets, and *Chot* with deck made of wooden planks and often mechanised with engines varying from 7.5 to 120 h.p. according to sizes are used in the operation of drift nets and seine nets.

Fishing gear

1. *Bag net*

(a) *Behundi jal:* There are different types of tackles under this group. They are operated against current to catch fish through filteration. Nets meant for bottom and surface differ in their design and mode of operation. When some are used for fishing throughout the year, others are restricted to seasons. There are types earmarked for fishing according to lunar phases.

The fishes caught in *Behundi jals* are sciaenids, anchovies, *Thrissocles, Setipinna, Coila, Harpodon nehereus, Parapenaeopsis* sp., *Metapenaeus* spp., *Acetes* sp., and squids.

(b) *Panch kati cool jal:* This is also a conical net fixed against the current with the help of five bamboo poles and hence the name. Presently this is found only at Junput and it is used for fishing in spring tide throughout the year. Catches are similar to that of *Behundi jals.*

2. *Drift net*

Locally known as *bhasani* or *chandi jal* are now in extensive use at Digha, Saula, Junput, Bakkhali and Frazergunj. Decron is used for making the net at all places except Digha where tyrecord forms the raw material. Drift nets operate for about 10 days a month from June to September and 20 days a month from October to March depending on weather conditions. Catch by the drift nets constitute mainly of *Hilsa ilisha, Scomberomorus guttatus, Stromateus argentius, Arius* spp. and *Osteogeniosus militaris.* There are about 150 non-mechanised and 380 mechanised units with decron nets and about 70 mechanised units with tyrecord nets in this coast.

3. *Seine nets* ('Kachal')

Six country crafts with the net and a mechanised boat make one unit. The boat tows the country crafts to the grounds searching for *Hilsa.* When shoals are sighted, they are soon encircled by the net, and the foot rope is pulled up and made into a bag with the fish in. Soon after hauling, the fish is taken to Diamond Harbour or Calcutta. Apart from *Hilsa*, cat fish, pomfret and seer fish are also caught in this net. The operation of this net is restricted to October–February period. There are about 40 units based along the coast of Midnapur. The average annual catch per unit is 20 tonnes.

4. *Shore seine* ('Sarini')

The shore seines are used only at Digha and Chandpur area. There are about 44 units and the average annual catch per net is 20 tonnes. The fish caught are mainly sciaenids, *Thrissocles, Setipinna, Coilia*, juvenile pomfrets, *Leiognathus*, polynemids and cat fishes. Sometimes the cat fish are caught in shoals.

Constriants in fishing activities

Bulk of the catch in the coast come through mechanised sector. But lack of berthing and mooring facilities stand in the way of expansion of fishing fleets. Boats are anchored in the open waters and catches transferred to canoes and ferried to the shore especially at Digha, Junput and Frazergunj. Same difficulty is faced to take provisions, fishing implements etc. to the boat. In none of the landing centres there is adequate jetty facility. Construction of jetties is therefore an immediate need.

A number of boats anchored in the sea are lost every year during rough weather that suddenly bursts. Canals in the area are silted and not suited for navigation. If bar mouths of the canals are periodically dredged and kept good for passage, most of them can form

safe bases for fishing vessels and more people will venture forward to invest in fishing. Landmarks with signal lights in the bases are lacking now and their installation will assist navigation particularly at night.

Jadha, the largest fishing base of the coast is not connected by road. There is no cold storage or ice factory near about. As a result the catch is sun dried on beach when scarcity for fresh fish is acute in the nearby Calcutta market. At present there are only three small ice factories with a total installed capacity of 37 tonnes and it is too meagre to meet the needs of the area. An ice plant with cold storage facility in a central place like Balisai will boost the industry. Proper approach roads are also lacking. Drying fish on bamboo mats or on cement platforms will improve the quality of the products. Facilities for this now not available should also be developed without fail.

Frazergunj and Bakkhali, where 242 mechanised boats operate do not have a workshop near about. The vessels are to be taken to Calcutta for even small repairs at the expense of many fishing days and money. Establishment of a full-fledged workshop will step up fishing days and increase production.

A couple of years ago, a few 9.6 m Tamil Nadu trawlers were supplied to different co-operative societies by the Government of West Bengal. But from the beginning they have been used either as gill netters or carriers. Trawling is never tried here by the fishermen. It would be helpful if Government train up local fishermen in it and encourage trawling.

THE *DISCO VALAI**

The *dico vali* (disco net) is an adaptation of the triple-walled entangling net, the trammel net, which, in India, has hitherto been confined to reservoir and estuarine fisheries. Recently (July, 1984) it has been introduced in the sea in Tamil Nadu, especially, in very large numbers, in Kanyakumari District, very successfully to entangle prawn. Never before in recent years were the fishermen of Kanyakumari district so fascinated with a particular type of net as with *disco valai* (or dance valai, as they sometimes call it). That thousands of these nets have been sold within a period of a month in the district is unprecedented, and stands proof to the impressive performance of the gear so far. This net has become a threat here to the existence of the prawn gill nets *(ral valai*) which had dominated the small-scale prawn fishing scene till now, for the prawn gill nets are being hastily transformed into *disco valai* by executing the essential changes in them. As this report is being prepared in August, 1984, the net has spread to the southern tip of Kerala coast (Trivandrum district) also in good numbers. Information on the net for this report was collected from fishing villages in Kanyakumari district.

Disco valai is tri-walled and designed to be set at the bottom. It has a fine net of smaller meshes hung loosely between vertical walls of coarser net of much larger meshes so that fish passing through the outer wall carry some part of the finer net through the wall of the other side and are entangled in the pocket thus formed. Though mainly operated for prawn, this net also pockets other crustaceans, molluscs and fishes that move near the bottom of the sea. Gilling of larger fishes in the outer walls has also been reported.

The inner wall which has 4,500 horizontal and 72 vertical meshes of 20 mm bar is made of nylon twine (No. 1/2). The outer walls made of No. 2 nylon twines have 583 horizontal and eight vertical meshes of 135 mm bar. The webbing in both are rhomboidal. Polyethylene ropes (4 mm diameter) constitute the float line, the sinker line, the buoy rope, the pull rope and the mounting lines which form an integral part of the net. The head rope proper 100 m in length is formed of two ropes, the float line and the mounting line. Likewise, the foot rope, 100 m in length, is also comprised of two ropes, the sinker line and the mounting line. The floats numbering 168 in all are synthetic and round (50 mm diameter and 10 mm thick). The sinkers (500 numbers)

*Prepared by Jacob Jerold Joel, Vizhinjam Research Centre of CMFRI, Vizhinjam and I. P. Ebenezer, Field Centre of CMFRI, Kanyakumari.

are lead and barrel-shaped (20 mm long, 15 mm and 10 mm thick at the centre and sides respectively), each weighing 20 g.

The inner netting is hung from the mounting line of the head rope whereas the outer walls are tied at their upper and lower extremities to the inner wall two to four meshes away from the mounting lines. The floats are passed through the float line. The mounting and the float lines are rigged by rigging twines at intervals of 20 cm and 40 cm alternately, with one float in each 20 cm interval. Similarly the sinkers have been fixed on the sinker line by rigging the mounting and the sinker lines at regularly repeated intervals of 2 cm and 18 cm with one sinker in each 2 cm interval. Two granite stones, each weighing 1/2 kg are tied to each end of the foot rope to anchor the net in position. A marker buoy (alkathene jerry-can of 10 litre capacity) is attached to the buoy rope (40-45 m in length) which is the continuation of the head rope. This is used to locate the position of the gear in operation. The proximal ends of the head and the foot ropes are continued 3 m from each side, united at ends and prolonged further as the pull rope of 40–45 m length.

The proportion of the mesh size of the inner wall of the net to the outer is 1:6.75. The horizontal hanging coefficient of the inner wall is 0.55 and the outer 0.63. The required slackness of the inner wall to facilitate entanglement of the fish is effected by the relatively shorter distance between the upper and lower lines of attachment of the outer walls.

A net with 100 m-long head and foot ropes normally has a depth of 2.5 to 3 m. The length of a net is usually mentioned in the fishing villages in terms of the number of sinkers it has, say, a net with 500 sinkers, one with 750 sinkers and so on. While a net with 500 sinkers is common, those with sinkers up to 900 are also in use. The spacing in between floats and in between sinkers is uniform in different nets, but the length and depth vary, the latter being seldom more than 3.5 m.

The net at present is operated from catamaran of any length by one or two persons at depths up to 35 m.

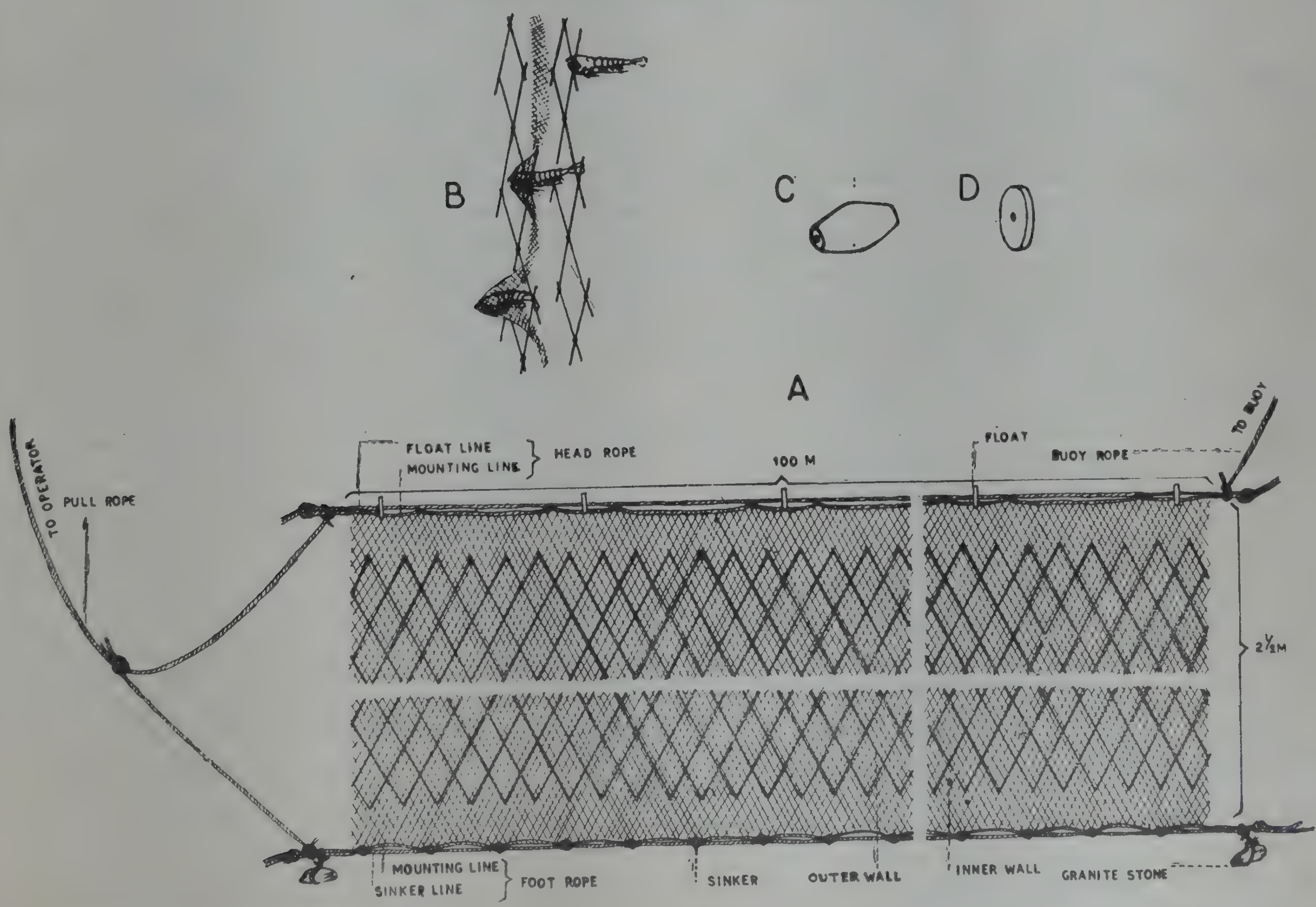

Fig. 1. (A) Design of a *disco valai*, (B) Mode of entanglement of prawn, (C) Sinker, and (D) Float.

The mode of operation is like that of any other bottom-set net.

At the time the net was introduced in Kanyakumari District during July 1984, a net with 500 sinkers cost about Rs. 1,355/- the approximate price details being:

5 kg polyethylene rope (4 mm dia.) @ Rs. 30/- per kg	—	Rs. 150.00
2.5 kg webbed (20 mm bar mesh) nylon twine code No. 1/2 @ Rs. 170/- per kg	—	Rs. 425.00
1 kg webbed (135 mm bar mesh) nylon twine code No. 2 @ Rs. 140/- per kg	—	Rs. 140.00
10 kg lead sinkers (20 g each) @ Rs. 25/- per kg	—	Rs. 250.00
170 synthetic floats (50 mm dia., 10 mm thick) @ Rs. 0.40 per piece	—	Rs. 68.00
1 alkathene jerry can (10 litre capacity)	—	Rs. 22.00
Labour charges	—	Rs. 300.00

But as the demand for the net is increasing day by day, the price of all components of the net has hiked up to 15% by August 1984, the net now costing Rs. 150/- to Rs. 200/- more than a month ago, especially, as fishermen from neighbouring Kerala State, who are unfamiliar with the know-how of its making, rush to Kanyakumari District to procure this net. The increase in price, however, does not seem to deter anyone from buying it since the intended catch is the highly priced foreign exchange earner, the prawn.

BIOACTIVITY IN ECHINODERMS*

Man in his pursuit for knowledge of newer and better drugs for eradicating diseases to which he is prone to has turned to the sea, which is a more potential treasure house of drugs due to its vast and diverse range of marine life. Many marine organisms exhibit toxicity as well as bioactivity. Some are toxic and lethal to terrestrial animals as well as to the man. These contain hitherto unknown chemical compounds which are pharmacologically active either against cancer, bacteria, virus, worms, ulcer, fertility, pains, cough and spasms, high and low blood pressure or promoting or inhibiting growth. In the recent years marine organisms are being screened for these activities and the causative chemical compounds isolated and studied in detail.

The Phylum Echinodermata consists of sea cucumbers (holothurians), star fishes and sea urchins. These are known for their toxicity. Primitive man used bits of some species of holothurians to stupefy fish from rocky pools and catch them. Some species of sea cucumbers are known to produce nausea to man when eaten. Baughinan (1951) had reported that crude star fish meal contained factors which inhibited growth of chicken. Hippocrates (Halstead, 1956) stated that ingestion of sea urchin may produce diarrhoea. Fürth (1903) quotes an old record that dogs and cats died from eating cooked starfish. The pedicellariae of sea urchin *Tripneustes gratilla* have been reported to produce swellings of the lips or mouth in Japan and that the ovaries of this urchin also produce the same reaction if they are not sufficiently washed before consuming (Yoshiro, 1979). It is also reported that dried starfish meal has long been used for extermination of harmful insects and fly maggots in Hokkaido and they have found that this meal inhibits ecdysis of fly maggots. The ovaries of the sea urchin, *Paracentrotus lividus* during their reproductive period are as lethal as puffer poison and the ovaries of the white sea urchin, *Tripneustes ventricosus* produce severe allergic symptoms when eaten.

The toxicity in a few holothurians to fishes has recently been studied by Bakus (1974) and by Bakus and Green (1974). They have found that the toxicity is inversely related to latitude. James (1980) has tried the toxin of *H. atra* to eradicate undesirable organisms from fish farms successfully at Mandapam.

This report deals with the results of the screening of 10 species of echinoderms collected from Gulf of Mannar area for biotoxicity to fishes and mice and also

*Prepared by D. S. Rao, D. B. James, K. G. Girijavallabhan, S. Muthuswamy and M. Najmuddin, Madras Research Centre of CMFRI, Madars.

for hemolytic activity. Of the 10 echinoderms, five were holothurians, viz. *Holothuria atra, H. scabra, H. spinifera, Bahadschia marmorata* and *Actiuocucumis typicus;* three star fishes, *Pentoceraster regulus, Astropecten indicus* and *Goniodiscaster scaber;* one sea feather, *Tropiometra carinata,* and one sea urchin, *Stomopneustes variolaris.*

The specimens were collected, and the bioassays for toxicity and hemolytic activity were started within one hour of collection. For each bioassay, 2 g of the part of the animal to be tested were extracted within boiling ethanol, solvent removed and the residue was dissolved in either sea water or distilled water or phosphate-buffered saline at pH7 depending on the type of assay involved such as fish toxicity, mice toxicity or hemolytic activity respectively. The parts of the animal used were body wall, viscera and cuverian tubules according to availability. In some cases, where weight of a part was not sufficient, the part available was used and the weights taken were naturally less for each bioassay. For fish toxicity, *Chanos* (average size 96.5 mm and average weight 6 g) and *Tilapia* fingerlings (average size 40 mm and average weight 0.9 g), were used. In the case of holothurians, the washings obtained, by cleaning the animal with sea water, was tested for biotoxicity for fish namely *Chanos, Tilapia* and cuttle fish (*Sepia* sp., average size 10 mm).

In the case of bioassays for toxicity on mice, 1 ml solution of the ethanolic extract residue dissolved in 10 ml of distilled water was injected intra-peritoneally into white (albino) mice of average weight 20 g. Hemolytic activity was studied with rabbit blood erythrocytes in phosphate-buffered saline at pH7 at 37°C using colorimetry. In all cases of bioassays, controls and blanks were maintained simultaneously with each experiment.

The results showed that all the parts of *Holothuria atra H. spinifera* and *Behadschia marmorata* exhibited a high degree of toxicity to fish fingerlings and mice and also destructive action on erythrocyte cells. The cuverian tubules of *B. marmorata* seemed to be highly toxic to *Chanos* and *Tilapia* fingerlings. These also showed strongest action on erythrocyte cells.

All organs of *H. atra* and *B. marmorata* were highly lethal and toxic to *Chanos* fingerlings while those of *H. scabra* and *H. spinifera* were less toxic. It was found that the toxin from the echinoderms *Actinocumis typicus, Pentoceraster regulus, Tropiometra carinata* and *Astropecten indicus* were only mildly toxic and were not lethal whereas *Goniodiscaster scaber* and *Stomopneustes variolaris* did not contain any substance toxic to *Chanos.* The action of the echinoderm extract on *Tilapia* fingerlings was more or less the same as for *Chanos.* Here also *H. atra,* and *B. marmorta* were highly toxic and *H. scabra* and *H. spinfera* were less toxic. The only change noticed was that for all other species of echinoderms tested, *Tilapia* continued to show normal behaviour. This may be due to the fact that *Tilapia* is more sturdy and resistant to changes in environments (except temperature) than is *Chanos.*

It was found that the toxins were water soluble from the fact that the aqueous washings showed similar toxicity to fishes. An interesting feature noted was that whereas the alcoholic extract of *A. typicus* did not show any lethality to *Chanos,* its aqueous washings showed clearly that this echinoderm contains water soluble and alcohol insoluble toxin which is concentrated in the body wall. Another interesting phenomenon noticed was that even the non-toxic and weakly toxic echinoderms (to *Chanos* and *Tilapia* fingerlings) were toxic and lethal to *Sepia* fingerlings except the star fish *Stomopneustes variolaris. Sepia,* thus seemed to be the most sensitive of all test fishes used.

The mice bioassay, showed that only two species of echinoderms, viz. *H.atra* and *B.marmorata* were toxic and lethal to mice.

All the echinoderms exhibited hemolytic activity thereby giving the true index of toxicity as the action is on the primary cellular level. The gradation of toxicity is brought out clearly by this assay. The gradation from strongest to weakest toxic species is *H. atra* (body wall and viscera), *B. marmorata* (body wall and cuverian tubules), *H. spinifera* (body wall and viscera), *H. scabra* (body wall), *P. regulus,* (body wall), *A. typicus* (body wall), *A. indicus, H. scabra* (viscera), *P. regulus* (viscera), *S. variolaris* (viscera), *G. scaber, T. carinata* and *A. typicus* (viscera).

Further detailed chemical investigations aimed at isolation and characterisation of the bio-active compounds present in these species are in progress.

The authors wish to express their thanks to Dr. E. G. Silas, Director for his keen interest in these investigations. They are grateful to Dr. P. V. R. Nair, Head of Fishery Environment Management Division, for his kind and useful suggestions. Thanks are also due to Shri K. Rangarajan and Shri. K. Mahadevan for extending facilities for these studies. The authors are

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FISH FOOD POISONING AT BALLY, HOWRAH*

On 17–6–1984, in the morning, a trader brought a basket of puffer fish *(Tetradon* sp.) to Ghoshpara, Bally, about 10 km from Howrah railway station and offered the fish for sale at the rate of Rs. 4/- per kg. The fish was quite new to the place. After the heavy rains and floods in the area from the end of first week of June there was a sudden hike in the price of fish in the market and the poor and middle class families were starved of fish. Therefore there was great demand for the puffer fish offered at a low price. Quite unaware of the death trap, about 49 families in the surrounding areas bought the fish. According to the information collected from the victims, some of the fish contained matured eggs. The fish were cooked after peeling off the skin. The eggs as well as abdominal fat were fried–in some cases with powdered gram ('basan'). The fish being cheap, each person consumed 75–100 g of flesh with their mid-day meals.

From 2 P.M. onwards fish food poisoning victims from all castes, age groups and from both the sexes started pouring in at Uttarpura General Hospital, about 2 km from Bally (Tables 1 & 2). Altogether 101 victims arrived in the same day, out of which, two were declared dead on arrival. The rush of the victims was so heavy that the doctors could not cope up with recording symptoms of individual cases.

The general symptoms were uneasiness, giddiness and loss of general senses. According to the symptoms, effect of the poison was neurotoxic acting on central nervous system. Vomiting was reported in a few cases, and those who vomitted suffered less and did not die. Those who were more affected appeared to have eaten more or eaten on empty stomach. On the following day, i.e. 18-6-1984 another 23 pessons were also admitted to the hospital. The admissions on the second day were more out of fear among people after the spread of fish food poisoning news. All were released from the hospital on 19–6–1984. It appeared that almost all the people who ate the fish turned upto the hospital. Majority of the victims were within 20 years of age. An age-wise analysis of the victims was: upto 20 years (68); between 21 & 50 years (49); and between 50 & 80 years (7).

There was acute convulsion in one case, and an unusal high dose of four calmpose injections within 15 minutes were administered to save the patient. The following treatment was prescribed in all the cases.

1. Dextrose 5% I.V.
2. Atropine
3. Decadron
4. Coramine
5. Calmpose

Besides the two brought dead to the hospital on 17th June, five others died in the hospital on the same day after receiving treatment for a short period as indicated in the table. Out of the seven persons dead, four were from the same family at Coomillapara and the other three were from two families at Ghoshpara. The dead persons were of different ages, from four year old child to 50 year old man. In a family of eight persons, seven survived after treatment but a child succumbed.

* Prepared by S. S. Dan, Field Centre of CMFRI, Contai, W. Bengal.

Table 1. *Number of families and victims in different localities of Bally, affected by eating puffer fish*

Locality	No. of families	No. of victims	Males	Females	Children within 12 years	No. dead	Remarks
Nischinta colony	2	5	3	2	3	—	—
Coomillapara	7	21	12	9	8	4	four dead from same family
Shyamaprasadpally	2	6	4	2	2		—
Ghoshpara	20	55	33	22	17	3	three dead from same family
Santinagar	2	8	4	4	4	—	—
Ma Saradapally	4	8	3	5	3	—	—
Ramachandrapur	2	4	2	2	1	—	—
Shrinagar colony	1	1	—	1	—	—	—
Sapripara	2	2	—	2	1	—	—
Anandanagar	2	2	—	2	—	—	—
Motinagar colony	5	12	8	4	3	—	—
TOTAL	49	124	69	55	42	7	

Table 2. *Particulars of victims who died after eating puffer fish*

Name of victim	Locality	Age	Sex	Date & time of hospitalisation	Date & time of of expiry	Remarks
Dulal Das	Coomillapara	20	M	17–6–1984 1455 hrs	17–6–1984 2040 hrs	Fell sick in hospital, giddiness, pulse subnormal, pupil reacting to light. No loss of consciouness.
Jiban Das	–do–	50	M	17–6–1984 1500 hrs	17–6–1984 1600 hrs	Symptoms not recorded.
Kachi Das	–do–	18	F	17–6–1984 1500 hrs	17–6–1984 17 hrs	–do–
Sambhu Das	–do–	22	M	—	—	Brought dead to hospital.
Prabir Bose	Ghoshpara	17	M	17–6–1984 1430 hrs	17–6–1984 1525 hrs	Symptoms not recorded.
Geeta Bose	–do–	35	F	—	—	Brought dead to hospital
Bapi Sarkar	–do–	4	M	17–6–1984 1915 hrs	17–6–1984 1925 hrs	Brought unconscious.

Shri Dulal Das of Coomillapara aged 20 brought all the other four members of his family to hospital who had developed poisoning symptoms. But after arriving in the hospital he suffered from dry tongue, chocked voice, subnormal pulse and pupil reacting to light but without loss of consciousness. He expired after 5 hrs 45 mts of hospitalisation after receiving treatment as mentioned above. Three other members died in the same family.

All the victims contacted, reported that the fish was not at all tasty. There was burning sensation as the fish passed through oesophagus. One Shri Bipul Bose was served with fish eggs and body fat fried in oil with his meal. As he felt the burning in the throat while swallowing and no taste for the fish, he did not take a second gulp of the egg and far or the flesh. He did not die, but had to be hospitalised along with other members of his family where his wife and a son succumbed. This showed that not only the flesh but eggs and oil of puffer fish were equally poisonous.

Compiled and prepared by Dr. M. J. George, Dr. K. J. Mathew, Mr. G. Nandakumar & Miss Jancy Jacob
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CONTENTS

Front cover photo: A nesting olive ridley at Gahirmatha, Orissa
Back cover photo: Hatchlings of olive ridley entering the sea at Gahirmatha, Orissa

ON THE LARGE AND MINI ARRIBADAS OF THE OLIVE RIDLEY *LEPIDOCHELYS OLIVACEA* AT GAHIRMATHA, ORISSA DURING THE 1985 SEASON

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Introduction

Our studies of the olive ridley along the east coast, particularly along the Gahirmatha coast (Silas *et al.*, 1983, 1984 and 1985) and those conducted by other workers (Bustard, 1976; Davis and Bedi, 1978; Kar, 1980, 1982; Bustard and Kar, 1981; Kar and Bhaskar, 1982; Kar and Biswas, 1982; Bhaskar, 1982; Kar and Dash, 1984; Whitaker, 1984 and Whitaker and Kar, 1984) indicate that there is a good amount of variation in the nature and intensity of arribadas from year to year (Table 1). While to some extent the time of occurrence of the first and second arribadas may be predictable within plus or minus a fortnight, the intensity and other aspects such as the extent of utilisation of beach areas; nesting during day time and so on differ greatly. We are documenting here our observations on the 1985 first and second arribadas of the olive ridley at Gahirmatha, which when critically examined deviate in many aspects from observations made on the arribadas during the earlier two years.

Table 1. *Details of estimated number of nesting females during arribadas at Gahirmatha from* 1976 *to* 1985 *season*

Year	Estimated number of nesting females	Source
1976	1,50,000	Kar and Bhaskar, 1982
1977	1,50,000	,,
1978	2,00,000	,,
1979	1,30,000	,,
1980	No data	—
1981	No data	—
1982	No mass nesting	—
1983	2,00,000	Silas *et al.*, 1983
1984	5,00,000	Silas *et al.*, 1985
1985	2,87,000	Present paper

First arribada of the olive ridley from 13-28 January, 1985

The mass nesting in 1985 was protracted over a period of 16 days from 13-1-'85 to 28–1–'85 with the peak nesting occurring between 16th and 19th January, 1985 (Table 2).

The beach configuration was quite normal as in previous years but the nesting was restricted to a stretch of 7.5 km of the Gahirmatha beach with almost saturation nesting occurring in a 4.5 km stretch with Ekkula as centre point. In earlier years, mass nesting was reported south of Ekkula but during 1982–'83 and 1983–'84 it was north of Ekkula. In fact, during 1984 season the first mass nesting occurred in a 5 km stretch from Ekkula northwards to Ekkula Nasi.

Similarly, unlike in the years prior to 1983, the first arribada of 1984 and 1985 was protracted occurring over a period of 15 and 16 days respectively. Normally the mass nesting activity is completed within a week. There is also some variability noticed in the total number of nesting females from year to year as seen from records by previous workers.

Except for a few straglers no large scale day nesting of olive ridley was noticed during the first arribada of 1985. This is quite different from 1984 season when on a single day as many as 45,0C0 olive ridely came ashore for nesting during day time on 26–3–1984 (Silas *et al.*, 1985).

As in previous years, a good amount of damage to nests of earlier batches was noticed by the waves of nesting influxes on subsequent days during the first arri-

Table 2. *Details of nesting females during first arribada at Gahirmatha in 1985 season*

Period of nesting	Estimated number of nesting females
13–1–1985	600
14–1–1985	1,000
15–1–1985	3,000
16–1–1985	50,000
17–1–1985	70,000
18–1–1985	80,000
19–1–1985	40,000
20–1–1985	16,000
21–1–1985	7,000
22–1–1985	1,500
23–1–1985	2,000
24–1–1985	2,500
25–1–1985	1,500
26–1–1985	1,000
27–1–1985	2,000
28–1–1985	1,500
Total	2,79,600

Table 3. *Details of number of nests destroyed by predators and successive nesters, freshly noticed tracks and carcasses observed in January, 1985 at Gahirmatha*

Place	Date	Km	Number of freshly noticed tracks	Number of carcasses	Number of destroyed nests
Ekkula Nasi	21–1–85	0–1	166	62	207
	–do–	1–2	289	48	310
	–do–	2–3	260	41	531
	–do–	3–4	404	42	664
	–do–	4–5	400	44	545
Ekkula	28–1–85	5–6	819	61	512
	–do–	6–7	381	106	286
	–do–	7–8	64	102	29
	–do–	8–9	—	86	9
	–do–	9–10	—	102	4
Total			2,783	694	3,097

bada. This year also we found no decrease in the level of predation by wild animals (jackals, hyaenas, pigs, feral dogs and birds). The only effective stoppage has been the poaching of eggs by man.

Although no mechanised fishing operations were noticeable off the Gahirmatha coast, a number of carcasses of olive ridley were washed ashore. About 694 in different state of decomposition were counted in a stretch of 10 km of beach (Table 3). Numerically this was far fewer than those observed in earlier years (Silas *et al.*, 1983). These carcasses could have been the result of animals getting entangled and drowning in fishing operations conducted off Paradip and adjacent areas, the carcasses drifting northwards and ashore at Gahirmatha. A good and sustained extension campaign to educate the coastal fishermen in the conservation and management measures being adopted for olive ridley along the Gahirmatha-Konarak stretch, calling for their co-operation and involvement in the programme is the need of the day. It cannot be a one time effort, and ultimately the State will have to introduce some regulatory measures to make matters legally binding.

The details of the size and weight of eggs observed during the first arribada are indicated in Table 4. Details of nesting area, size of nesting females, depth of nest, clutch size, distance of pit from high water mark, duration of incubation hatching success, nest temperature and ambient atmospheric temperature at night during the nesting period are given in Table 5.

The beach had a gentle gradient upto the stretch of sand-dune and almost 90% of the nesting was noticed along the base of the sand-dune in a narrow band hardly five metres in width extending along the 4.5 km stretch. In some areas where the sand-dune had a gentle gradient the nesting turtles ascended the slope for excavating the nests still higher up. The portion of the sand-dune with a steep slope no doubt acted as an impediment for the turtles to move further inland, thereby restricting the nesting area to a narrow width along the base of the sand-dune. We feel that any study of the nesting intensity of olive ridley should not only take the entire stretch of beach but also this aspect of saturation nesting along narrow belts into account. Beach improvements for nesting turtles may be necessary by creating a gentle gradient to afford greater areas of nesting which may also minimise nest destruction by influxes on subsequent nights. This aspect needs consideration as a management measure. However, any plantation of casurina or other vegetation in such beach area may again cause impediments, though it will be difficult to keep off a sand binder such as *Ipomea* sp. from spreading wild in such areas.

Incubation period

Hatchlings of the first arribada of 1985 season were seen to emerge after 60 days (Table 5).

We have also carried out observations as to the number of nests at random from which hatchlings have emerged during the different nights to find out whether there was any particular trend of intensity of emergence.

Observations during different nights indicated that emergence took place 60 days after nesting and there was some amount of correlation between the peak mass nesting and emergence of hatchlings (Table 7).

Table 4. *Variation in the diameter in mm and weight in gm of eggs of olive ridley from 10 clutches (mean in parenthesis) at Gahirmatha examined by authors in 1985 season (Ten eggs were taken at random from each clutch)*

	First mass nesting January, 1985		Second mass nesting March, 1985	
	Diameter (mm)	Weight (gm)	Diameter (mm)	Weight (gm)
1.	37.1–39.8 (38.4)	29.0–33.2 (30.6)	36.5–38.1 (37.1)	28.5–31.8 (30.2)
2.	35.1–38.4 (36.4)	29.0–31.2 (29.8)	34.1–37.0 (35.7)	25.8–28.0 (26.8)
3.	33.4–36.9 (35.5)	29.0–32.0 (29.8)	36.3–39.6 (38.7)	28.5–33.5 (30.5)
4.	37.1–40.1 (37.8)	29.0–33.0 (31.2)	37.6–40.6 (39.1)	31.0–33.3 (31.9)
5.	33.2–39.7 (36.8)	30.0–35.0 (32.4)	35.6–38.7 (37.3)	29.1–34.2 (30.8)
6.	38.7–40.0 (39.2)	33.0–35.5 (34.6)	35.4–37.3 (36.1)	25.7–30.4 (28.3)
7.	37.0–38.4 (37.6)	31.0–33.0 (31.5)	36.5–39.1 (37.6)	29.5–31.7 (30.7)
8.	37.3–39.1 (37.7)	30.0–32.0 (31.2)	35.0–37.8 (36.5)	28.3–30.8 (29.2)
9.	37.1–35.8 (38.0)	30.0–32.5 (31.8)	38.2–40.7 (34.0)	32.3–35.1 (33.5)
10.	—	—	35.7–39.6 (37.8)	28.2–31.3 (29.2)
	N = 90	90	100	100
	R=33.4-40.1	29.0-35.5	34.1-40.7	25.7-35.1
	M = 37.50	31.41	37.43	30.11

Quantitative analysis on hatching success for different clutches of the mass nesting are given in Table 8. A significant observation was the very low intensity of second arribada which did not damage or cause mortality of hatchlings and developing embryos of the first arribada unlike in earlier years. We feel that the success of hatchlings resulting from the first arribada was better in 1985 season than 1984 season when the second arribada of equal magnitude as the first, and along the same stretch of beach, resulted in mass destruction of developing eggs, eggs in pipping stage and heavy mortality of emerging hatchlings.

Second arribada of olive ridley at Gahirmatha in 1985

After an interval of 58 days of the completion of the first arribada, the second arribada commenced on 13–3–'85. In effect this was an anticlimax since unlike in previous years hardly 8,083 turtles came ashore for nesting over a period of 10 days. We have reservations whether this qualifies to be denoted even as a mini arribada. In 1984 the number was around 2,00,000. Detailed enumeration of date wise emergence for nesting for the 1985 second arribada is given in Table 9. The peak was on the nights of 17th and 18th March, 1985 when 3,000 and 3,500 turtles respectively came ashore for nesting. The reason for this very low intensity is not clearly understood. The conditions noticed at Gahirmatha during the second mass nesting need recording.

1. There was extensive erosion along the beach and the 10 km stretch of nesting beach was greatly reduced and in some places only a ledge existed on which turtles had to crawl over to nest. Due to the restricted width of the beach, nesting was seen even at high water mark level and very often this resulted in the nest being washed away and eggs exposed and lying free in the intertidal zone. On 21-3-'85 in a short stretch, as many as 25 nests were seen lying exposed along the edge of the ledge abuting on the high water mark due to wave action. During the early hours of dawn, sea birds were seen preying on the exposed eggs and many eggs had rolled down the beach.

The extent of exposed beach during the first and second mass nesting differed widely as indicated in Table 4.

2. There was no indication of intense second mass nesting in other beaches along the Orissa coast as monitoring was done at several points.

3. During the second arribada, there was strong sea-to-land wind for most part of the day which also resulted in heavy wave action.

Table 5. *Details of first and second arribadas of 1985 season at Gahirmatha*

Parameter	1985 First arribada	1985 Second arribada
1. Estimated number of nesting females	2,79,600	8,083
2. Area of nesting (km)	6.2	4.0
2a. Duration of nesting in days	16	11
3. Size of nesting females:		
a) Carapace length in cm	65–74 (72.9) N=108	68–74 (72.1) N = 10
b) Carapace width in cm	62–73 (71.6) N = 108	69–72 (70.6) N = 10
c) Weight in kg	32–48 (46.8) N = 108	37.5–46.5 (42.0) N = 14
4. Depth of nest in cm	43–63 (49.5) N = 9	38–56 (46.0) N = 9
5. Nest temperature in °C	25.5–27.8 (26.4) N = 1	29.2 – 32.0 (30.2) N = 10
6. Ambient atmospheric temperature at night in °C	21.7–23.8 (22.9) N = 9	25.9–26.9 (26.3) N = 9
7. Clutch size	97–128 (113) N=9	102–162 (136) N = 9
8. Distance of pit from high water mark in m	48–55 (50.7)N=10	2–30 (12.7) N = 10
9. Incubation duration in days	60	—
10. Hatching success in per cent	89.0	—

Table 6. *Variation in the size in mm and weight in gm of olive ridley hatchlings from 10 clutches (mean in parenthesis) at Gahirmatha examined by the authors during the 1985 season*

Sl. No.	No. of turtles	Carapace length	Carapace width	Plastron length	Plastron width	Weight	No. of right lateral scutes 5	6	7	8
1.	N = 20	35.3–39.0 (37.38)	28.9–33.1 (31.19)	29.0–31.4 (29.96)	23.5–28.3 (26.18)	12.0–15.5 (13.60)	0	11	9	0
2.	-do-	38.7–42.9 (41.31)	31.2–37.2 (35.02)	31.9–34.3 (33.25)	26.9–31.2 (28.44)	16.0–19.5 (17.99)	0	11	6	3
3.	-do-	36.7–42.8 (40.38)	33.3–36.6 (35.06)	30.8–34.8 (32.94)	27.6–31.0 (29.76)	15.7–17.3 (16.58)	1	11	6	2
4.	-do-	37.9–41.5 (40.47)	32.7–35.8 (33.87)	30.4–34.1 (32.09)	27.0–30.3 (29.02)	16.0–18.2 (27.87)	0	17	2	1
5.	-do-	38.4–41.4 (39.67)	32.2–35.6 (33.87)	28.8–32.8 (31.07)	25.4–29.0 (27.79)	14.7–17.5 (16.12)	0	13	7	0
6.	-do-	38.8–42.2 (39.52)	32.1–36.3 (34.23)	29.6–32.9 (31.87)	27.6–30.8 (28.99)	17.0–18.5 (17.94)	0	11	7	2
7.	-do-	37.2–40.8 (39.86)	31.2–39.4 (33.06)	30.1–32.0 (31.13)	26.4–28.8 (27.72)	16.5–19.0 (17.20)	0	10	10	0
8.	-do-	38.1–41.8 (39.11)	31.5–35.3 (33.34)	29.5–32.5 (30.54)	25.7–29.3 (27.86)	15.5–18.0 (16.87)	1	9	8	2
9.	-do-	38.5–42.3 (40.18)	32.1–35.5 (33.37)	30.1–34.5 (32.39)	27.3–30.4 (28.59)	17.0–19.2 (18.49)	0	7	9	4
10.	-do-	34.7–39.4 (36.77)	30.1–34.7 (32.04)	30.2–34.2 (32.06)	27.3–30.2 (28.53)	13.6–17.0 (15.45)	2	10	8	0
							4	110	72	14
		N = 200	200	200	200	200				
		R = 34.7–42.9	28.9–39.4	28.8–34.8	23.5–31.2	12.0–19.5				
		M = 39.4	33.50	31.73	28.6	16.72				

Table 7. *Details of emergence of hatchlings from nests observed in March, 1985 at Gahirmatha*

Date	Number of nests from which hatchlings emerged
14–3–1985	400
15–3–1985	500
16–3–1985	2,300
17–3–1985	5,000
18–3–1985	25,000
19–3–1985	16,000
20–3–1985	12,000
21–3–1985	10,000
22–3–1985	1,000
Total	72,200

The details about the clutch size, size of individual eggs and their weights seen in the arribada are given in Tables 3 and 4.

Mini arribadas have been known to occur at Gahirmatha during certain years although we do not have well documented information on the same. It will be interesting to see whether there are any cyclic occurrence of large and mini arribadas. Continuous monitoring over a period of time may give answers to this. The number of remigrants in the second arribada is also an unknown factor. There were a number of abnormal animals seen emerging for nesting in the mini arribada, some successfully completing the nesting operations.

As earlier indicated, the second arribada also coincided with the emergence of hatchlings of the first arribada but with no mortality to emerging hatchlings.

Table 8. *Details of live hatchlings emerged, live in pipping stage, dead hatchlings noticed in the pit, dead in pipping stage and spoilt and unfertilized eggs observed (percentage in parenthesis) during March,* 1985 *based on the observations made by the authors at Gahirmatha*

Date	Clutch size	Live hatchlings emerged	Live hatchlings in pipping stage	Dead hatchlings in pit	Dead hatchlings in pipping stage	Spoilt and unfertilized eggs
16–3–1985	166	157 (94.57)	1 (0.60)	1 (0.60)	—	7 (4.21)
–do–	133	117 (87.97)	10 (7.52)	2 (1.50)	1 (0.75)	3 (2.25)
–do–	83	71 (85.54)	1 (1.20)	1 (1.20)	8 (9.63)	2 (2.40)
–do–	114	105 (92.10)	2 (1.75)	2 (1.75)	1 (0.87)	4 (3.50)
–do–	133	119 (89.47)	—	1 (0.75)	5 (3.76)	8 (6.01)
–do–	96	69 (71.87)	—	3 (3.12)	19 (19.79)	5 (5.20)
–do–	125	115 (92.00)	5 (4.00)	1 (0.80)	3 (2.40)	1 (0.80)
–do–	142	116 (81.69)	5 (3.52)	6 (4.22)	10 (7.04)	5 (3.52)
–do–	117	105 (89.74)	—	—	3 (2.56)	9 (7.69)
18–3–1985	108	92 (85.18)	7 (6.48)	—	2 (1.85)	7 (6.48)
–do–	73	68 (93.15)	—	—	1 (1.37)	4 (5.48)
–do–	118	98 (83.05)	8 (6.78)	1 (0.84)	6 (5.08)	5 (4.23)
–do–	121	109 (90.08)	2 (1.65)	2 (1.65)	1 (0.82)	7 (5.78)
–do–	155	145 (93.54)	1 (0.64)	2 (1.29)	—	7 (4.51)
–do–	122	117 (95.90)	2 (1.63)	2 (1.63)	—	1 (0.81)
–do–	161	159 (98.75)	—	—	—	2 (1.24)
–do–	151	139 (92.05)	5 (3.31)	—	—	7 (4.63)
–do–	165	159 (96.36)	—	2 (1.21)	2 (1.21)	2 (1.21)
–do–	108	93 (86.11)	1 (0.92)	1 (0.92)	10 (9.25)	3 (2.77)
–do–	127	120 (94.48)	—	—	4 (3.14)	3 (2.36)
–do–	142	111 (78.17)	1 (0.70)	2 (1.40)	2 (1.40)	26 (18.30)
–do–	127	109 (85.82)	7 (5.51)	1 (0.78)	6 (4.72)	4 (3.14)
–do–	100	95 (95.00)	1 (1.00)	2 (2.00)	—	2 (2.00)
Total	2,887	2,588 (89.7)	59 (2.0)	32 (1.1)	84 (2.9)	124 (4.3)

Table 9. *Details of nesting females during the mini arribada at Gahirmatha in March,* 1985

Period of nesting	Estimated number of nesting females
13–3–1985	40
14–3–1985	35
15–3–1985	85
16–3–1985	300
17–3–1985	3,000
18–3–1985	3,500
19–3–1985	900
20–3–1985	150
21–3–1985	25
22–3–1985	48
Total	8,083

A dead sea gull lying on the beach was examined and remains of soft parts of hatchlings were seen in the stomach. Gulls were also seen picking up hatchlings from and beyond the surf. Actual feeding in flight was not noticed. Crows were seen pecking at the live hatchlings as they were crawling towards the sea in the early hours of the day. This year we have also seen dogs preying on hatchlings. Unlike the 1984 season, only very few dead hatchlings were seen along the beach, mostly remains of those killed by birds.

Emergence of hatchlings

Some observations were made on the emergence of hatchlings and sequence of events thereafter. The series of photos given in Plates II–V indicate the sequence. It was invariably seen that all hatchlings headed towards the sea, the crawl marks falling within 110° to 140° on the seaward side of the nest (Plate V).

Due to intense erosion, once the hatchlings reached the edge of exposed beach ledge, they tumbled down over a metre of height to the intertidal area and thence entered the water.

Hundreds of hatchlings were also seen swimming in the adjacent estuarine area. They would have got there from the sea through tidal action. Such occurrence of hatchlings in the estuary has also been noticed earlier by us (Silas *et al.*, 1985).

Estimation of hatching success

In view of the second arribada being a mini arribada, it was reasonably possible to estimate the number of first arribada nests from which hatchlings emerged. Our observations on successive nights corraborated with that of the Forest Department give the figures indicated in Table 6. Thus it would appear that only 26% of the nests resulted in giving rise to successful emergence of hatchlings. As indicated earlier, larger number of nests were destroyed by the influx of fresh batches of turtles coming for nesting over a protracted period of time during the first arribada itself.

We have also studied in detail the hatching success for 23 clutches which is shown in Table 7. This would give an average of 115 hatchlings as successfully emerging from a clutch. On this basis it is estimated that about 8.3 million hatchlings would have emerged successfully from the first arribada where 2,79,600 turtles were estimated to have nested over a 16 day period in January, 1985. Since the observations of the emerging hatchlings were carried out only on nine days, it is felt that the estimate of 8.3 million may be an underestimate. However, we are presenting this figure as indicative of what had happened at Gahirmatha and not as absolute figures. We have no quantified data on the amount of predation by mammals and birds on hatchlings. A proper statistically designed sampling method may have to be evolved for the estimation of egg mortality and hatching success of the olive ridley at Gahirmatha.

We hope that the points raised in this paper will help focus more attention on the olive ridley problem at Gahirmatha.

Is the time of commencement of an arribada predictable?

The CMFRI team visited the Bhitarkanika Wild Life Sanctuary and specifically Gahirmatha and collected data on the occurrence of arribada during the years 1983, 1984 and 1985 (Fig. 1). During the 1983 season from 3rd to 9th February about 2,00,000 olive ridleys nested in the first arribada. The arribada commenced on the 5th day after the full moon in January, 1985. We have no information about the second arribada.

During the 1984 season the first arribada started on 25th January and lasted upto 6th February and about 3,00,000 olive ridleys nested and the arribada started on the 7th day after the full moon and the second arribada of the 1984 season also started on the 7th day

PLATE I. A. Tracks of olive ridleys during first mass nesting at Gahirmatha; B. Olive ridley nesting in sandy beach; C. Olive ridley nesting in an elevated beach among plants and D. A group of olive ridleys nesting on sandy beach during the first arribada at Gahirmatha.

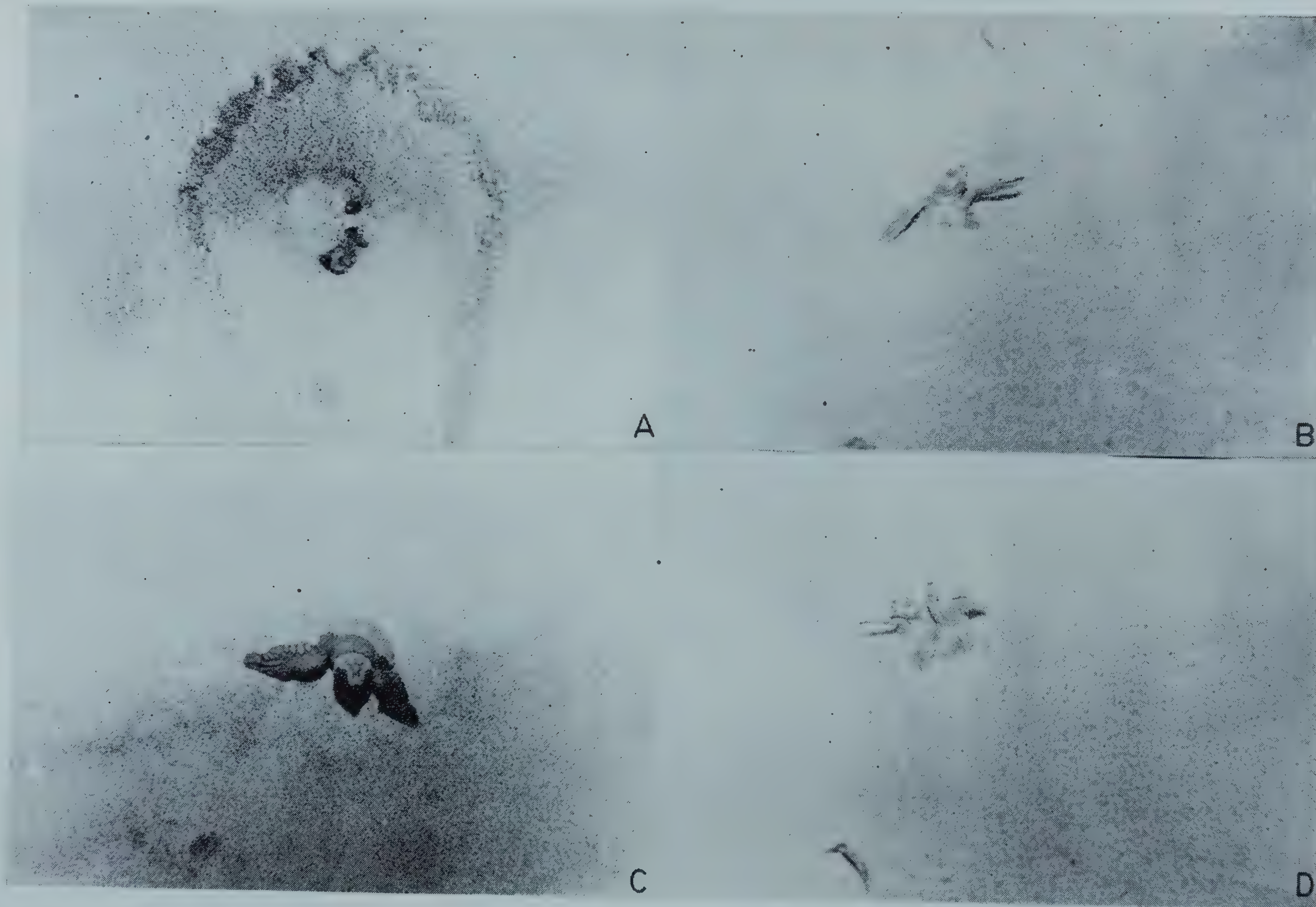

PLATE II. A. 'Caving in' of sand is an indication before the emergence of hatchling from the nest; B. Emergence of hatchling from nest even without 'caving in'; C–D. Emerging hatchling from nests.

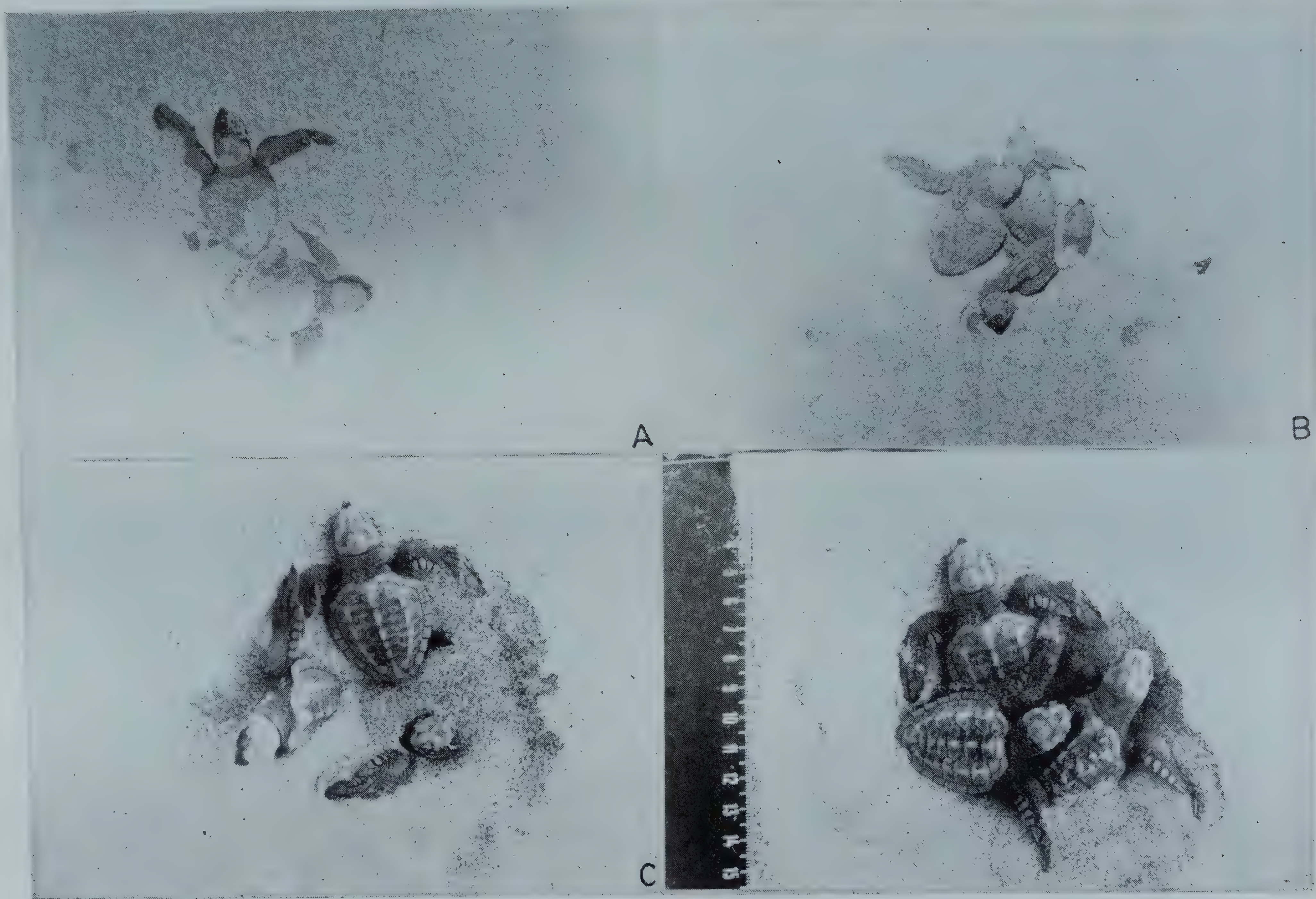

Plate III. A–D. Different stages of emerging of hatchlings from the nest.

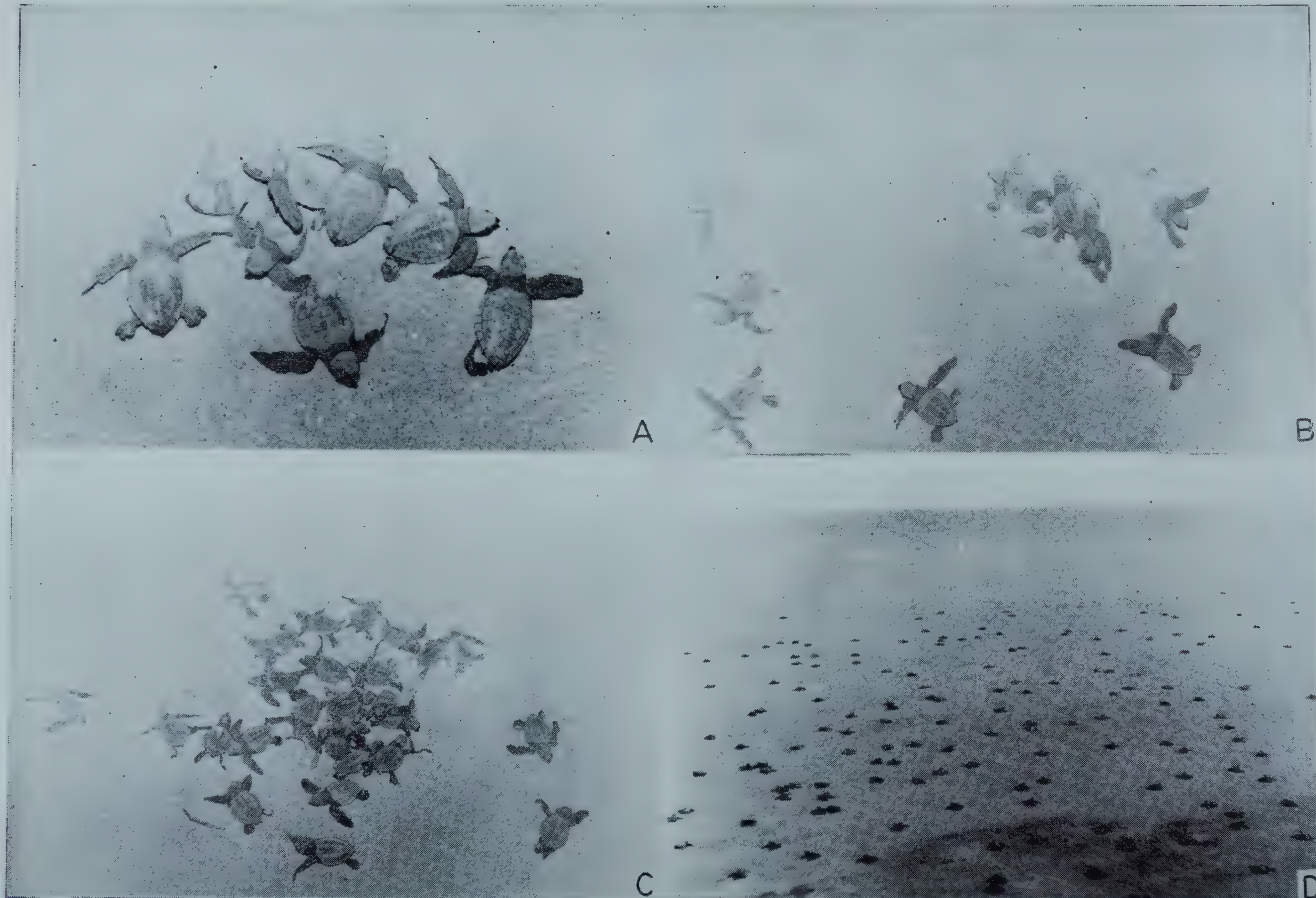

PLATE IV. A. Emergence of hatchlings from the nest; B–C. Hatchlings heading towards the sea; D. Hatchlings entering the sea at Gahirmatha.

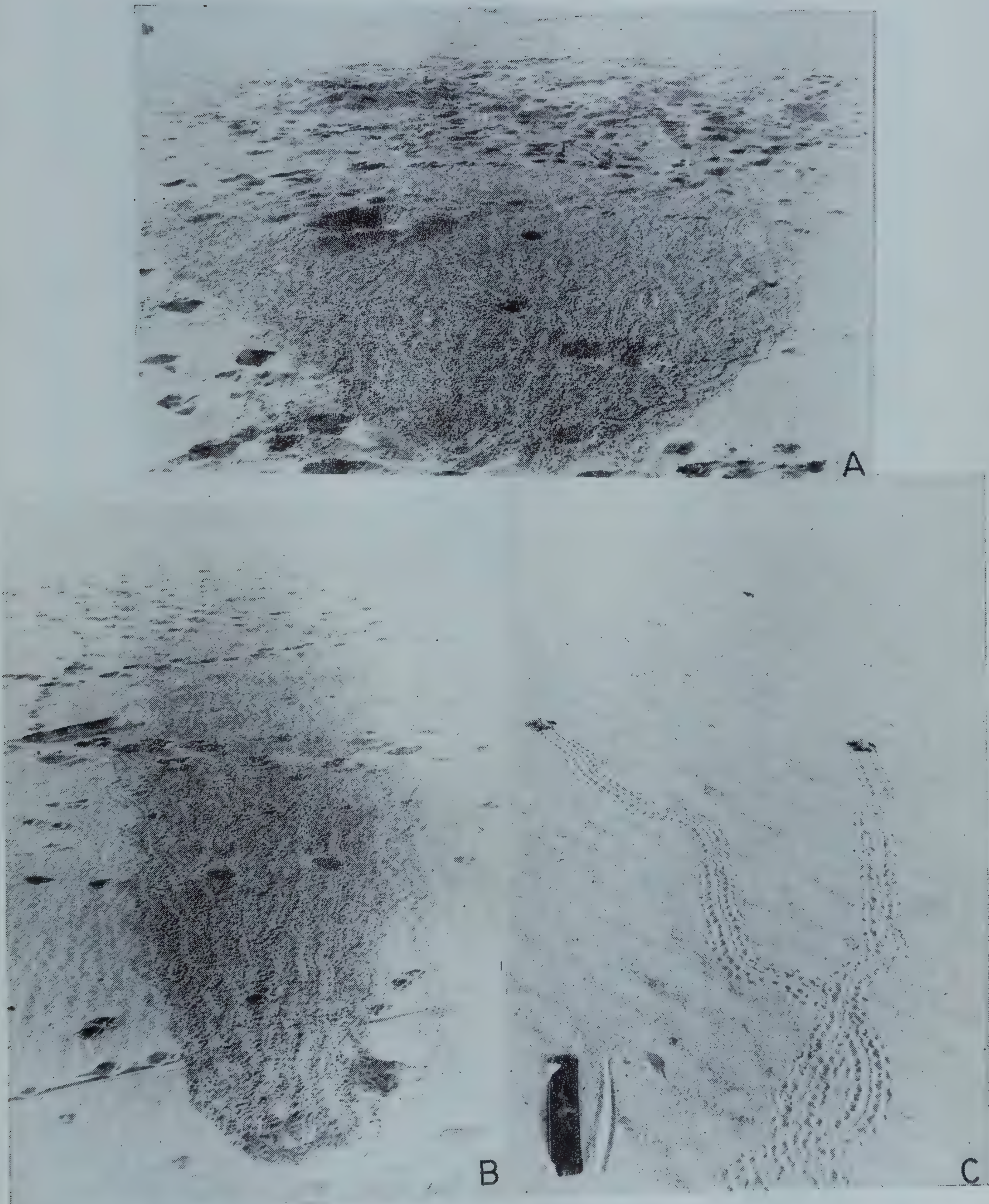

PLATE V. A and B. Tracks of olive ridley hatchlings falling 140° and 110° with the nest as the base point and, C. Track of olive ridley hatchling heading towards the sea.

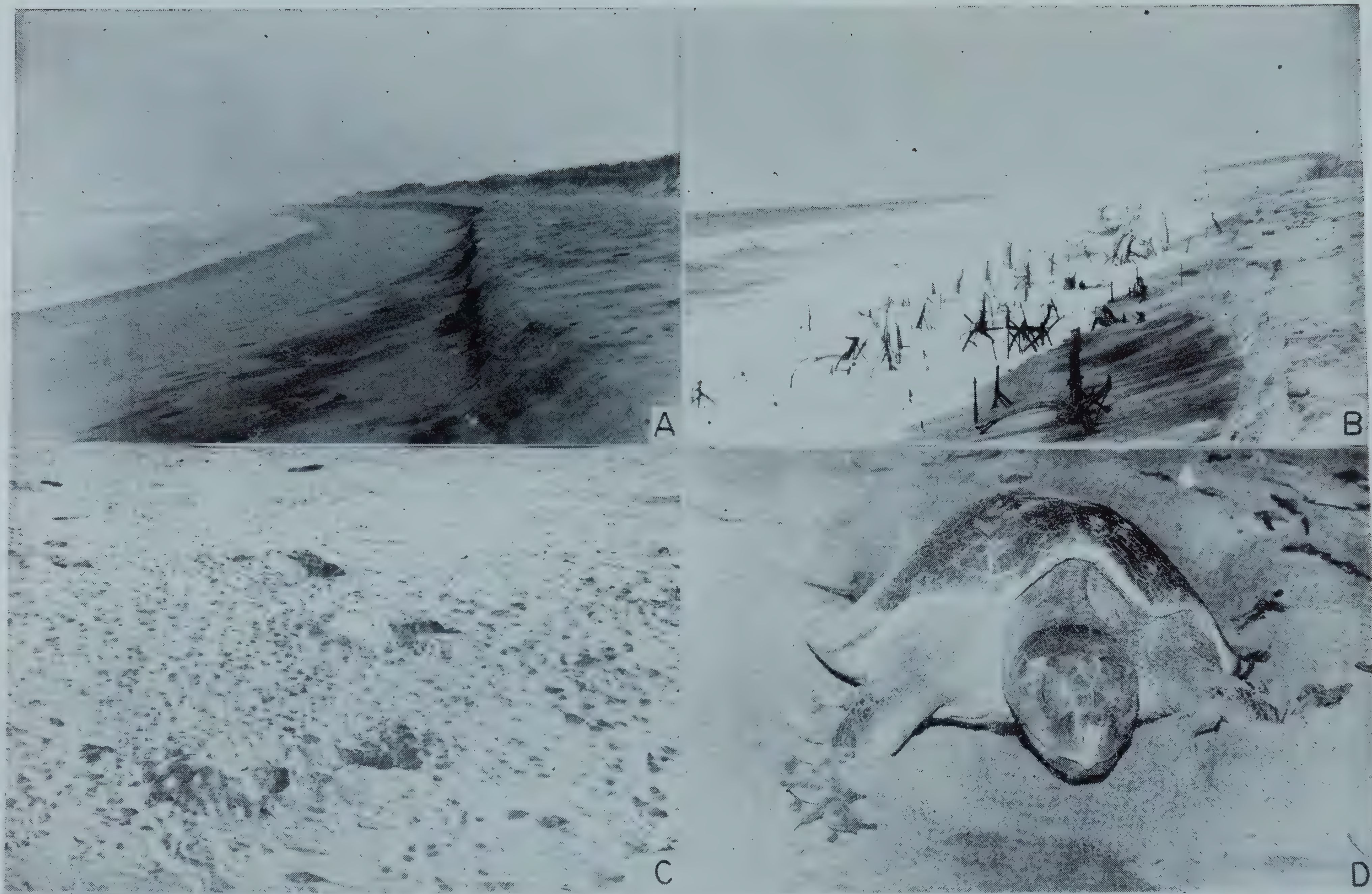

PLATE VI. A. Beach configuration at Gahirmatha during the second arribada; B. Remnants of mangrove at Gahirmatha beach: C. Predation of eggs at Gahirmatha by animals and D. Nesting olive ridley in the midst of emerging hatchlings during the second arribada.

PLATE VII. A. Carcasses of olive ridley washed ashore along Gahirmatha beach noticed in January, 1985; B. Crows feeding on the hatchlings at Gahirmatha; C. Sea gulls predating on the hatchlings; D. Dog feeding on olive ridely eggs at Gahirmatha.

PLATE VIII. Olive ridley returing to sea after nesting at Gahirmatha.

after full moon in March. The first and second arribadas of 1985 season also showed the same trend of occurrence of arribada on the 7th day after the full moon.

The occurrence of arribada can be correlated with the phases of the moon and this has been reported by Marquez *et al.* (1976), Marquez and Van Dissel (1982) and Kar and Dash (1984). From our observations it is clearly evident that there is need to critically examine whether a correlation exists between the occurrence of an arribada and the lunar phases. What we have given here is only indicative. Corroboration of this from past data as well as studies on sea conditions and other environmental and oceanographic parameters are now needed.

Illegal exploitation of sea turtles

Despite the protection accorded to sea turtles under Schedule I of the Indian Wildlife (Protection) Act 1972, the illegal exploitation of sea turtles was still in existence as late as 1984–85 seasons along the West Bengal and Orissa coasts. Earlier instances have already been reported by several workers [Biswas (1982), Bobb (1982), Davis and Bedi (1978), Kar (1982), Shekar Dattatri (1984) Silas *et al.* (1983 a, b), Ganguly (1980) and Raut and Nandi (1985)].

In this account we are reporting about some of the illegal trade which had come to our notice during the 1984–85 season. In view of the stern action taken by the officials of Forest Department, Government of West Bengal, the organised fishing for turtles which

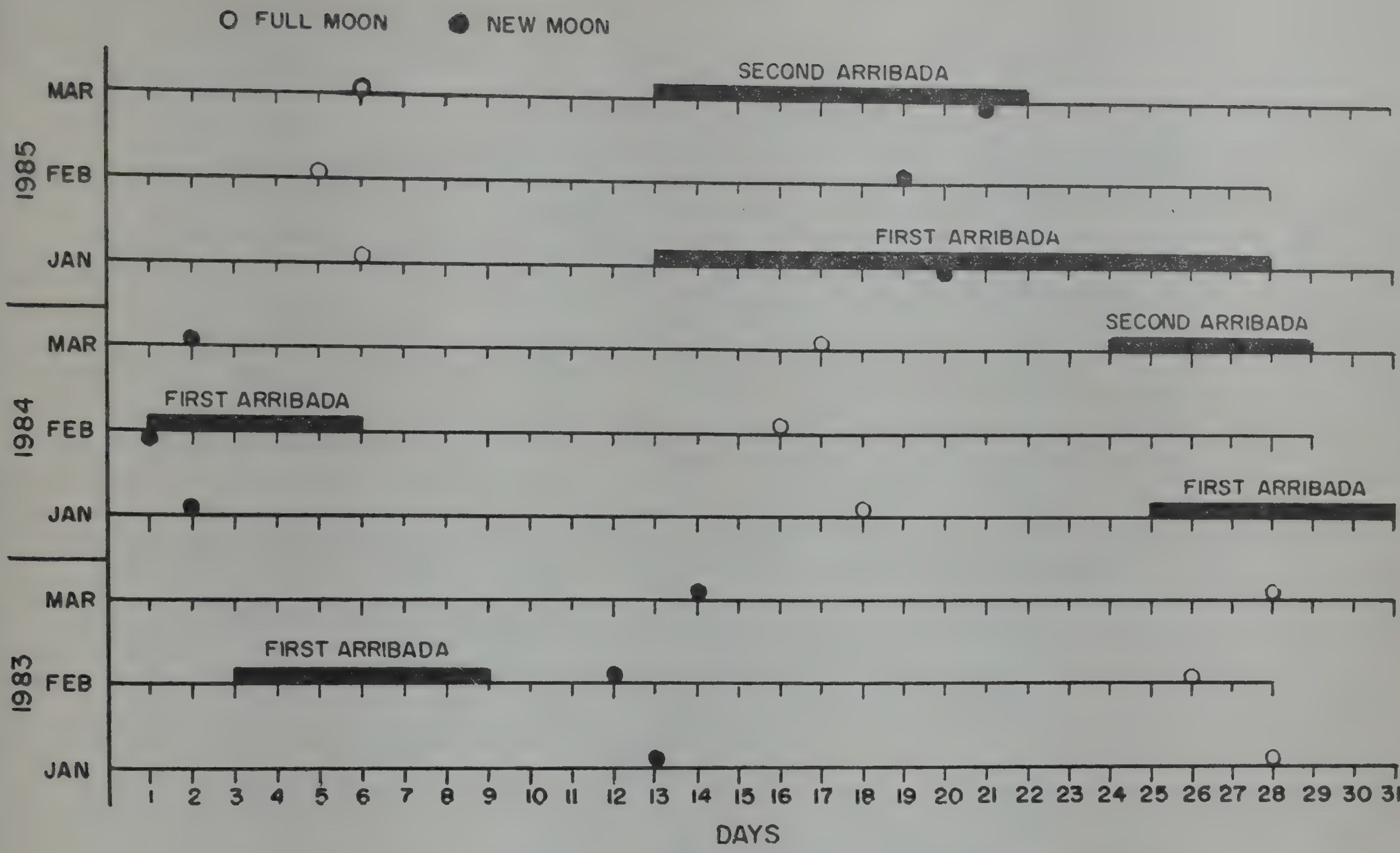

Fig. 1. Occurrence of arribadas at Gahirmatha, Orissa in relation to the phases of the moon.

existed prior to 1983 season has been completely stopped. However, the incidental catch of sea turtles in the gill nets operated by West Bengal fishermen are brought ashore and transported to interior markets.

At Digha

During 1984-85 season from the middle of October, 1984 to November, 1984 on an average 10 to 15 olive ridleys were landed at Digha and Digha Muhana.

The numbers came down to five or six per day during December, 1984. Due to the vigilance of forest officials, the turtles were transported from Digha and Digha Muhana fish landing centres to interior markets under cover. In view of the risk involved the price of the turtles at these landing centres varied from about Rs. 20 to 25 per turtle. The number of turtles noticed by us is given below:

Date	Place	Number of live ridleys noticed
8–11–1984	Digha	10
10–11–1984	Digha	2
10–11–1984	Digha Muhana	10

On 10–11–1984 we have noticed about 70 carcasses of olive ridley at the Digha and Digha Muhana fish landing centres.

At Diamond Harbour

From mid-October to end of November, 1984 on an average eight to 10 turtles were noticed at the Diamond Harbour whole sale fish market and these were from the incidental catches in the gill nets. At Diamond Harbour the turtles were sold around Rs. 60 to 80 a turtle. Unlike at Digha, the sale of turtles was openly carried out at the fish landing centre and in the fish market. Those noticed by the CMFRI team at the landings centres and market are given in Table 10.

Other centres

Other than Digha and Diamond Harbour, sale of turtles was noticed at Sagar Island, Frazergunj, Namkhana, Jetty Ghat and Dasmile in 24 Parganas District, West Bengal. We have seen on 22–11–1984 three olive ridleys being carried openly in a cycle rickshaw to Kali Bazar in Sagar Island. On 7–12–1984 one olive ridley was loaded at Frazergunj on the roof of a passenger bus but on the timely intervention by the Additional Divisional Forest Officer, 24 Parganas, the turtle was carried back and released near Namkhana.

Table 10. *Number of olive ridleys noticed at the landing centres and markets*

Date	Place	Number of olive ridleys
21–10–1984	Diamond Harbour fish market	4
22–10–1984	,,	6
25–10–1984	Diamond Harbour fish landing centre	3
28–10–1984	Diamond Harbour fish market	12
19–11–1984	Diamond Harbour fish landing centre	5
22–11–1984	Diamond Harbour fish market	10
22–11–1984	Diamond Harbour fish landing centre	3
24–11–1984	Diamond Harbour fish market	8
25–11–1984	,,	18
26–11–1984	,,	16
27–11–1984	,,	16
6–12–1984	,,	27
7–12–1984	,,	29
8–12–1984	,,	44

Following are a few of the press reports of happening which we felt should be recorded (Appendices I–III).

Conclusion

It is quite obvious that implementing the Wildlife (Protection) Act is still a problem. While efforts should not slacken, it is also appropriate to see whether a part of the 'doomed eggs' of the large arribadas could be collected for use as food. How much of removal will be permissible is an open question. Management advise will be needed on this and decisions can be made in the field only on the basis of the intensity of an arribada. If this is feasible, and the beaches are well protected from poaching, a well regulated controlled harvesting of the 'doomed eggs' and marketing the same through only Government channel may be thought of. This question has earlier been raised by Silas (1984: *CMFRI Bull.* 34) and also discussed at the 'Workshop on Sea Turtle Conservation' held in Madras in February, 1984 *(CMFRI Special Publ. No.* 18: 1-119, 1984). This appears more logical than harvesting adult turtles. The time has come when we should bestow more serious attention to this as a measure in the conservation and management of this resource.

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Appendix I

'DAINIK CHETNA' dated 14-1-1985

(Bengali daily published from Contai)

Lorry load sea turtles seized

Dated 13th January, 1985

Today at about nine in the night rickshaw labourers seized a truck at 'Caltex More'. The number plate of the lorry was not clear. The truck driver attempted to run away with the truck but the public and rickshaw labourers prevented it. Basisthamuni Kunar, the driver was taken to the police station and the truck was kept under the custody of the police. According to the driver there were more than 54 sea turtles in the truck. The driver confessed to the police that two persons from Tekhali village named Mahim Patra and Baneswar have purchased the turtles at Digha and were transporting them to Calcutta. It is legally prohibited to capture and sell sea turtles. Sea turtles are reducing fast in number and on way to extinction and hence sea turtles are declared as protected animals.

লরী বোঝাই সামুদ্রিক কচ্ছপ আটক

কাঁথি ১৩ জানু, আজ রাত ৯টা নাগাদ কাঁথি ক্যালট্যাক্স মোড়ে রিক্সা শ্রমিকরা একটি ট্রাক অবরোধ করে। ট্রাকটির নম্বর প্লেট অস্পষ্ট করে রাখা হয়েছে। ট্রাক চালক গাড়িটি না থামিয়ে দ্রুত বেরিয়ে যাওয়ার চেষ্টা করে কিন্তু বহু মানুষ ও রিক্সা শ্রমিকরা তা হতে দেননি। চালক বশিষ্ঠমুনি কুণ্ডরকে কাঁথি থানায় হাজির করা হয় এবং ট্রাকটি থানার হেপাজতে রাখা হয়। ঐ ট্রাকে চালকের কথামত চুয়ান্নটির বেশী সামুদ্রিক কচ্ছপ আছে। পুলিশের কাছে স্বীকারোক্তিতে ট্রাক চালক বলে যে তেখালি গ্রামের মহিমপাত্র এবং বানেশ্বর নামে দুইজন দীঘায় ঐ সামুদ্রিক কচ্ছপ কিনে কোলকাতা নিয়ে যাচ্ছে। ট্রাক চালকের কথামত ট্রাকটির নম্বর হল ডব্লু, বি, ওয়াই ৩৭৭০। সামুদ্রিক কচ্ছপ ধরা এবং বিক্রী করা নিষিদ্ধ। এইধরণের কচ্ছপের সংখ্যা দ্রুত কমে গিয়ে ধ্বংস হতে চলেছে এবং এরফলে প্রাকৃতিক ভারসাম্য ক্ষতিগ্রস্ত হচ্ছে। সেই কারণে সামুদ্রিক কচ্ছপ এখন সংরক্ষিত প্রাণী।

Appendix II

'DAINIK TEERBHUMI' dated 14-1-1985

(Bengali daily published from Contai)

Illegal trade of sea turtles

Staff Reporter: Despite the legal protection given to sea turtles the sea turtle trade is still in existence. Policemen of Contai police station seized a lorry loaded with sea turtles on Sunday. 55 sea turtles were transported from Digha to Calcutta by a lorry No. 3770. The sea turtles are regularly caught and transported from Digha, Junput, Jaldha and Satbhaia to interior markets eventhough forest department has declared it illegal to capture and sell turtles. Forest department has established check posts to prevent illegal trade of turtles. Despite the steps taken by police and forest officials the illegal trade is carried out under cover.

মেদিনীপুর জেলার প্রথম ও বহুল প্রচারিত

দৈনিক তীরভূমি

১৩৯১ ॥ সে'মবার ॥ ১৪ জানুয়ারী ১৯৮৫ মূল্য : ২০ পয়সা

বে-আইনী সামুদ্রিক কচ্ছপ পাচার হচ্ছে

স্টাফ রিপোটার : সামুদ্রিক কচ্ছপ ধরা আইনত নিষিদ্ধ হলেও তার ফলাও কারবার চলছে। রবিবার কাঁথি থানার পুলিশ সামুদ্রিক কচ্ছপ ভর্ত্তি একটি লরি আটক করে। এতে ৫৫টি বড মাপের কচ্ছপ ছিল। ডবলু বি আই ৩৭৭০নং লরিতে করে ওই কচ্ছপগুলি দীঘা থেকে কলকাতা চালান দেওয়া হচ্ছিল পুলিশ লরিটির গতিরোধ এবং আটক করে। বন দপ্তর সামুদ্রিক কচ্ছপ ধরা বেআইনী করলেও দীঘা জুনপুট জলধা বাকশালে এবং বর্ডারের সাতভাঁয়া এলাকায় প্রায় নিয়মিত এগুলি ধরে চালান দেওয়া হচ্ছে। যাতে কচ্ছপ ধরে চালান দিতে কেউ না পারে সেজন্য বন বিভাগ বনরক্ষীদের চেক পোষ্টে নজর দারীর ব্যবস্থা করে। তা সত্ত্বে বনরক্ষী ও পুলিশকে নাকি নজরানা দিয়ে চালানদার এক চক্র উচ্চ মূল্যে কচ্ছপ চালান দিয়ে চলেছে। কোন কোন ক্ষেত্রে পুলিশ ও বনরক্ষীদের চোখ এড়িয়ে এই কারবার চলে।

ছুটী

আজ সোমবার মকর সংক্রান্তি উপলক্ষে পত্রিকা দপ্তর ছুটী। মংগলবার পত্রিকা প্রকাশিত হবে না

Appendix III

'DAINIK CHETNA' dated 16–1–1985

(Bengali daily published from Contai)

Live sea turtles released into the sea

Dated 15th January, 1985

Yesterday the police produced the accused Basisthamuni Kunar driver of lorry No. WBY 3770 and the trader Mahim Patra of Tekhali village before the court on the charge of smuggling sea turtles. The Judge Alok Kumar Mukhopadhyaya ordered to release 29 live turtles into the sea. The seized lorry, its driver and Mahim Patra were released on bail.

29 turtles were released into the sea on the holy 'Makar Sankranti' day in the presence of many bathers Sri Devasis Majumdar, member of Wildlife Protection Society, Sri Birendranath Biswas, Circle Inspector, Contai police station were present at the time of release.

The driver went away with the lorry and 21 dead turtles. Turtle flesh was sold at the rate of Rs. 10 per kg and approximate value of those 21 turtles will be around rupees eight thousand. Police is not able to trace Baneswar who is being considered to be the leader of the illegal trade.

Since 1982 so far 253 sea turtles including the present consignment have been caught by police while being smuggled. This is the second time that the police released sea turtles into the sea. Police seized 39 and 90 sea turtles on 17th and 21st December, 1982 respectively and 71 sea turtles on 31st January, 1984 and 50 sea turtles this time. On one previous occasion dead sea turtles were sold by auction.

জীবন্ত সামুদ্রিক কচ্ছপ সমুদ্রে ছাড়া হ'ল

১৫ জানুয়ারী, বে-আইনীভাবে সামুদ্রিক কচ্ছপ চালান করার অভিযোগে রবিবার ধরা অভিযুক্ত ডব্লু বি আই ৩৭৭০ লরির চালক বশিষ্ঠমুনি কুণ্ডর এবং সামুদ্রিক কচ্ছপ পাচারকারী তেখালি গ্রামের মহিম পাত্রকে কাঁথির পুলিশ গতকাল আদালতে হাজির করে। বিচারপতি অলোককুমার মুখোপাধ্যায় ২৯টি জীবন্ত কচ্ছপকে সমুদ্রে ছেড়ে দেওয়ার আদেশ দেন! আটক লরি ও তার চালক এবং মহিম পাত্রকে জামিনে মুক্ত থাকার আদেশ হয়।

পুণ্য মকর সংক্রান্তির দিন বহু স্নানার্থীর সামনে ২৯টি কচ্ছপকে সমুদ্রে ছেড়ে দেওয়া হয়। বন্য প্রাণী সংরক্ষণ সমিতির সদস্য দেবাশিস মজুমদার, কাঁথি পুলিশের সার্কেল ইন্সপেক্টর বীরেন্দ্র নাথ বিশ্বাস এই সময় উপস্থিত ছিলেন।

মৃত ২১টি কচ্ছপ নিয়ে অভিযুক্ত লরি ও তার চালক চলে যায়। ঐ লরিতে পুলিশের দু'জন সশস্ত্র প্রহরী ছিল। ঐ কচ্ছপের মাংস দশটাকা কেজি দরে বিক্রী হয়ে থাকে। ২১টি মৃত কচ্ছপের আনুমানিক মূল্য প্রায় আট হাজার টাকা। পাচারের ব্যাপারে পালের গোদা বলে যাকে মনে করা হচ্ছে সেই বানেশ্বরের হদিশ পুলিশ এখনও পায়নি।

এবার নিয়ে ১৯৮২ সালের ডিসেম্বর মাস থেকে ২৫৩টি সামুদ্রিক কচ্ছপ চোরাই ভাবে পাচার করতে গিয়ে পুলিশের হাতে ধরা পড়ে। পুলিশ এবার নিয়ে দু'বার জীবন্ত কচ্ছপগুলি সমুদ্রে ছাড়লো। ১৯৮২ সালে ১৭ ডিসেম্বর ৩৯টি ২১ ডিসেম্বর ৯০টি, ১৯৮৪ সালে ৩১ জানুয়ারী ৭৪টি এবং এবার ৫০টি সামুদ্রিক কচ্ছপকে পাচারকারীদের কাছ থেকে পুলিশ আটক করলো। ইতিপূর্বে একবার মৃত কচ্ছপগুলিকে নীলামে বিক্রী করা হয়।

CONSERVATION OF MARINE TURTLES IN ANDHRA PRADESH*

Different organisations in India like Central Marine Fisheries Research Institute, Cochin, Forest Departments of Tamilnadu, Orissa and West Bengal are actively engaged with sea turtle conservation programmes. Valuable survey work has been carried out on sea turtles in Andaman and Nicobar Islands (Bhaskar, 1984). Recently, Whitaker and Kar (1984) reported a number of major and minor nesting beaches of olive ridley sea turtles. According to them, minor nesting of olive ridleys occurs in Andhra Pradesh. Silas *et al.* (1984) viewed that while migrating to reach the nesting grounds along the Orissa coast (Gahirmatha coast), stray numbers of ridley may be digressing to the shores of Tamilnadu and Andhra Pradesh. There is an urgency to survey along the Andhra Pradesh coast to locate nesting beaches of sea turtles, since no systematic survey work has been undertaken on this coast (Kar, 1983).

During a preliminary survey (Feb. 11–18, 1984) along the Andhra Pradesh coast, in a 25 km stretch from Kakinada (16°57′N, 82°12′E) to Konapakapeta, it was reported by fishermen that nesting of sea turtles (vernacular name of all species: *Samadrapu Tabelu)* occurred in the area and if they happened to see turtle tracks they digged the nests to take away the eggs for food. Through the survey it came to know that a number of olive ridleys nest in this coast.

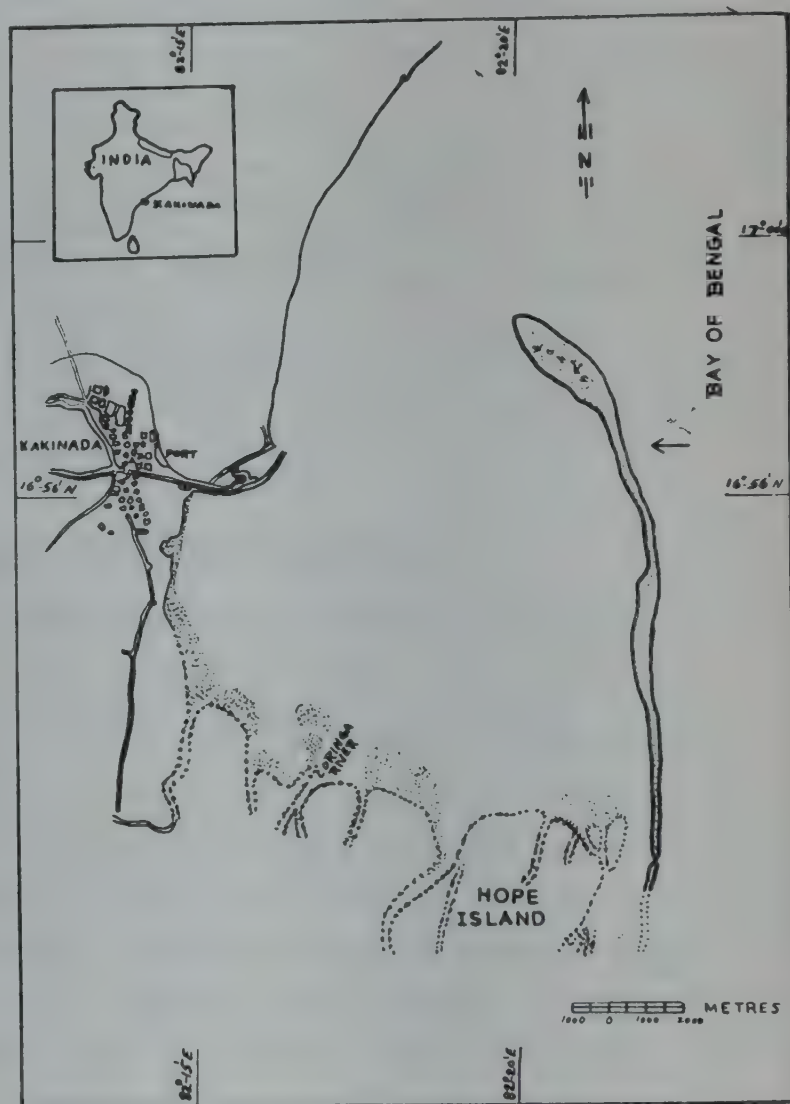

Fig. 1. Olive ridley nesting beach (arrow point) on Hope Island near Kakinada, Andhra Pradesh. Note the mouth of Coringa river. This river is declared as a crocodilian sanctuary.

I found a nesting beach of olive ridleys on Hope Island (Fig. 1), 7 nautical miles east to Kakinada, A.P. where nine predated nests were located. No undisturbed nests were found According to fishermen, this island is a good nesting site for ridleys but majority of the nests were either predated by jackals or searched by the fishermen of the Island for the eggs. The author happened to see two fishermen on the Island searching for eggs on 18th February at 5.30 A.M. The fishermen are completely unaware of the wildlife protection laws.

Exporting of marine turtles was not reported in this coast but a section of fishermen known as 'Oda Baljees' eat the turtle meat. On 12–2–1984, a ridley turtle (69 cm carapace length) was killed and the local fishermen at Mulapata, 20 km north to Kakinada, cousumed the meat. The carapace was found on the following day. Mating turtles in the sea and females on the shore are habitually caught by the fishermen.

Incidental catch of breeding adults by fishing trawlers is more on this coast. Many carcasses of ridley were found which were reported to be caught by mechanised trawlers along this coast, where 1,207 registered trawlers move every day. The owners of the trawlers told that a number of sea turtles were incidentally caught in their nets from October to February.

*Prepared by R. J. Rao, National Chambal Sanctuary, Morena.

In Andhra Pradesh, Coringa Wildlife Sanctuary, 20 km south to Kakinada was declared in July, 1978 to rehabiltate the Saltwater crocodile, *Crocodylus porosus* which is believed to be absent in that area.

It is suggested that the conservation programme of marine turtles near Kakinada coast and Hope Island should be included in the conservation management programme of Coringa Wildlife Sanctuary. The sanctuary boundaries should be extended and inshore use of trawlers and fishing nets during mating and nesting season of Olive ridleys in the sanctuary should be regulated by instructing the port and fisheries departments. Fishing nets should be specially designed to avoid incidental catch of the turtles. Under the sanctuary management programme, sea turtle recovery programme in Andhra Pradesh should be started, as in Tamilnadu, by constructing turtle hatcheries in important nesting sites like Hope Island to incubate eggs under protected conditions.

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ECONOMICS OF TURTLE CATCH IN WEST BENGAL*

An investigation was carried out during the months of November and December, 1983 to study the economics of turtle catch in the coastal belt of West Bengal. The data relating to income and expenditure of different units were collected from Midnapore district of West Bengal where the turtles caught from Orissa coast were landed. An attempt is made here to understand the factors responsible for the expansion of turtle fishery in Orissa and West Bengal, the distributional aspect of the accrual of benefits among different categories of operators and the impact of Government intervention to prohibit the turtle catch.

Turtle marketing

In the sixties, the turtle catch in West Bengal was occasional. Casual landings of turtle were observed at Digha as by-catch when monofilament gill net was introduced. The entangled turtles are caught by holding the flippers and pushing them inside the boat. After turning the animals upside down the flippers were tied together with thin galvanised iron or nylon string to avoid escape. The fishermen landed their catches at Digha and Banksalghat landing centres where they were sold to the turtle traders.

The fishermen were not interested to catch turtle on commercial basis, since its consumption was confined primarily to the lower stratum of the society in areas adjacent to the coastal belts of West Bengal only.

Gradually the fish traders started transporting few numbers of turtle along with the fish to Calcutta and Howrah to find out market, as well as to observe its demand. In Calcutta and Howrah a large percentage of the population is from East Bengal to whom the turtle meat is a delicacy. Therefore the turtles introduced into Calcutta and Howrah markets were very well received by the Bengalis and this caused an

*Prepared by Kamalkumar Datta (C.M.F.R.I., Cochin) and S.S. Dan (Field Centre of C.M.F.R.I., Contai, W. Bengal)

increase in price. Soon the turtles were introduced to Siliguri also where they realised more price.

As a result, there was tremendous competition between the traders of south and north Bengal to capture the market by offering higher prices. The average price of a turtle in Howrah and Siliguri markets is given in Table-3. The expansion of the external market for turtle in conjunction with a decrease in its costs of transportation (a consequence of the extension of the transportation network linking the interior coastal belts to the distant large urban centres) resulted in its increased profitability. In addition to this, since turtle catch was relatively a sure event, less uncertainity was involved in its fishery as compared to fish catch. This ensured a steady income for the fishermen.

Table 1. *Number of different units from different places engaged in turtle catch in different years*

	Howrah	Midnapore		
Years	Country boat	Country boat	Trawler	Launch
1977–78	—	7	—	—
1978–79	—	11	—	—
1979–80	6	14	2	1
1980–81	65	38	12	3
1981–82	110	42	15	8
1982–83	32	22	12	4

The above mentioned facts removed the constraints inherent in turtle fishing for commercial purpose and led the fishermen of West Bengal to locate Gahirmata (a place in the district of Cuttack in Orissa) as a ground for turtle fishing. The outcome of all these efforts got reflected in the increase in the number of units operated over the years (Table-1) and the number of trips made in a season (Table-2). Onward journeys to Gahirmata took one or two days due to favourable northern winds, but the return journeys were hazardous which took 8–9 days for a country craft. As a result 40–60% mortality took place. Each boat brought 80–120 animals depending on the size of the boat.

From 1980 onwards, the necessity of the country boats to be towed by motor launches and trawlers was strongly felt because it helped them to increase their

Table 2. *Number of trips by different units in a season (November to January) from* 1978–'79 *to* 1982-'83

Units	Years				
	1978–'79	'79–'80	'80–'81	'81–'82	'82–'83
Country boat	2–3	3–4	9–10	6–7	3–4
Trawlers	1–2	6–7	9–10	6–7	3–4
Launch	1–2	3–4	8–9	4–5	3–4

income in two ways; (a) it took less time, say a maximum of 48 hrs for a trip. By being towed by the trawlers or launches it helped to reduce mortality rate of the animal from 40–60% to 10–15%; (b) secondly, a boat in a season usually made maximum 3–4 trips, but after introducing trawlers and launches it increased upto 10 trips in a season.

Table 3. *Average price per turtle in different months of the season from producers market to intermediate market in* 1982–83

Months	Price at the landing centre (Rs)	Howrah market (Rs)	Siliguri market (Rs)
November	55.00	90.00	120.00
December	45.00	75.00	110.00
January	28.00	55.00	85.00

Income and expenditure of different units

It has been observed that the owners engaged 3–4 labourers for turtle catch in case of a trawler or fishing launch whereas in the case of country boats, 5-6 persons jointly hired a boat at Rs. 500 for four months, and they shared the net income equally after deducting the operational expenditure.

Fuel is the major cost item for trawlers and launches, accounting for about 90% of total operational cost (Table 4).

The major cost component for a country craft is towing charges, which amounted to 70% of total expenditure.

Table 4. *Cost and earnings (in Rs.) of different units in a trip in 1982-83*

Units	EXPENDITURE Food	Fuel	Towing	Rent for a boat	Wages	Total cost	INCOME From turtle	From towing	Total income	Income over operational cost
Country craft	200	12	700	150	—	1,062	2,900	—	2,900	1,838
Trawler	207	980	—	—	300	1,487	1,870	4,900	6,770	5,283
Launch	200	920	—	—	300	1,420	2,000	2,805	4,805	3,385

The income over the operational cost was estimated to be Rs. 1,838 for a trip in case of a country craft, whereas in case of a trawler or fishing launch it was about Rs. 5,283 and Rs. 3,385 respectively.

The operators of trawlers and launches earned more than that by a country craft because their sources of earnings were in two ways (a) from capture of turtle and (b) from towing the country craft.

In 1982 the West Bengal Government enforced the Indian Wild Life Act, 1972 (Amendment, October '77) though landing still continues in some unscheduled places. However, the immediate result was the decrease in the numbers of units operated and the number of trips made by each category in 1982–83 (Table 1 & 2). This apparently gave a big jolt to the employment opportunities and income of the area covering a total of about 16 villages; nine in Midnapore, four in Howrah and three in 24 Parganas. About six persons, on an average, were engaged in each boat. With the enforcement of the Act, the scope for employment opportunities appear to get minimised all over the areas.

Conclusion

The emperical findings reported here reveal some important aspects. In the first place, the rising price of turtle over the years drew the interior coastal economy into the distant urban market, but this has helped to strengthen the position of a few economically and socially namely, the operators of trawlers and the mechanised boats and secondly, once drawn into the urban commercial circuit, the rural coastal scenario could not escape the demonstration effect of urban centres, the result of which gets manifested in the change of living standard of the people associated with country boat.

But consequent upon the contraction in the employment opportunities arising out of the restriction and the near absence of employment prospects outside the agricultural sector, they are forced to curtail their consumption but less than proportionately, since consumption in any period is geared to the history of income.

Extensive study is necessary to find out the detailed biology, and stock position of the species and if controlled fishing can be allowed so that the species does not face extinction and at the same time help to maintain the existing living standards of the fishermen.

LEATHER-BACK TURTLE CAUGHT OFF DEVBAG NEAR MALWAN*

One leather-back turtle *(Dermochelys coriacea)* caught accidently off Devbag at 18 m depth near Malwan on 1–4–1985 in a gill net was found stranded on the beach on 5–4–1985. The specimen had a carapace length of 149.8 cm and a width of 109.0 cm. The length of the plastron was 142.5 cm while the width measured 72.5 cm. The turtle had seven longitudinal (dorsal) ridges on the carapace and five longitudinal ridges on the plastron. The skin was smooth and the head had no scutes. The flippers were clawless.

*Reported by J. P. Karbhari, Bombay Research Centre of C.M.F.R. I., Bombay.

Compiled and prepared by Dr. M. J. George, Dr. K. J. Mathew, Mr. G. Nandakumar & Miss Jancy Jacob
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THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the National Marine Living Resources Data Centre (NMLRDC) and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

Abbreviation – *Mar. Fish. Infor. Serv. T & E Ser.*, No. 65: 1985

CONTENTS

Front cover photo: A carrier boat full of prawns *(Metapenaeus dobsoni)* caught in purse seine off Malpe
Back cover photo: *M. dobsoni* caught in purse seine off Mangalore

THE PRAWN FISHERY OF THE SOUTH KANARA COAST WITH EMPHASIS ON THE UNUSUAL CATCHES OF *METAPENAEUS DOBSONI* BY PURSE SEINES AND TRAWLS DURING THE FIRST HALF OF SEPTEMBER, 1983

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Introduction

The large scale introduction of purse seines along the South Kanara coast in late seventies, and the subsequent addition in the following years, were mainly intended to exploit the vast pelagic resources of this region. Prawns, being demersal in habit, were seldom caught in purse seines except in a few sporadic cases. However, the unexpected heavy catches of prawns in purse seines, particularly in the beginning of the fishing season, ie., in the first few days of September, have been a boon to a large number of purse seiners since the last two to three seasons. The commencement of the 1983–'84 fishing season witnessed bumper catches of prawns *(Metapenaeus dobsoni)*, particularly in purse seines, breaking all previous records. The unprecedented catch of *M. dobsoni* in purse seines necessitated intensive monitoring of the data in order to find out whether there was any over-fishing during this period resulting in the depletion of the resources. With this in mind, a programme was worked out to collect all basic data from important centres in South Kanara. The data from Mangalore (Bunder), and Malpe (Fisheries Harbour) were collected on a day-to-day basis, while Gangolli where the prawn landing was generally poor during this period, was observed only on a few occasions and the catch data was collected mostly on enquiry. Based on the above studies, an appraisal of the prawn fishery of the South Kanara coast by purse seiners during the first half of September, 1983 has been attempted here. The prawn landings by shrimp trawlers during the above period have been incorporated in order to make the study more comprehensive as well as to get a clear picture of the prawn landings in this area. Since *M. dobsoni* formed the bulk of the prawn catch, a brief account on its resource is also included.

Fishing operations

The craft and gear employed in purse seine fishery together with its mode of operation along the South Kanara coast have been mentioned by Dhulkhed *et al. (Mar. Fish., Infor. Serv. T & E Ser., No.* **37,** 1982). Similarly, the trawl unit and its operation have been reported by Sukumaran *et al. (Mar. Fish. Infor. Serv. T & E Ser., No.* **44,** 1982).

During this period, fishing was mostly carried out within 18 m depth. The units operating from Mangalore fished north of Mangalore, off Panambur, Suratkal, Mulky, Hejamadi, Padubidri, Kaup etc. from 1st to 9th September. There was a peak in the prawn catches in the first few days and a gradual decline was noticed from 4th to 9th September. There was a second peak from 10th onwards lasting up to 15th September. During the second peak, most of the fishing for prawns was carried out south of Mangalore (off Uppala, Kasaragod, Kanhangad etc.). At Malpe, except on 5th September, fairly good catch of prawns was obtained up to 7th September. The units were operated south of Malpe, and the fishing area was extended up to Kaup. It was found that a large number of purse seines and trawl units belonging to other centres like Hangarkatta and Gangolli were operated from Malpe during this period.

Each purse seiner, generally made one to four hauls per day, each lasting 1–3 hours. Each unit was found to engage one carrier boat during this period, for transporting the catch after one or two hauls.

Prawn production during the first half of September, 1983

It is estimated that around 1,939.0 t of prawns landed in the South Kanara coast during the first half

of September, 1983 as against 1,187.2 t of prawns landed during the corresponding period of 1982 (Table 1). This showed an increase of about 63.3% in prawn landings. During this period, the prawn catches were so unprecedented that it alone accounted for about 34% of the 11 years annual average landings of prawns of Karnataka for the period 1971–81.

Table 1. *Estimated prawn landings in tonnes by mechanised units at Mangalore, Malpe and Gangolli during the first half of September,* 1983 *(September,* 1982 *data is also given for comparison)*

Centre	1983	1982	increase during 1983 (%)
Mangalore	1,318.4	710.3	85.6
Malpe	565.5	430.9	31.2
Gangolli	55.1	46.0	19.8
Total	1,939.0	1,187.2	63.3

A. Gear-wise analysis of the prawn landings

1*) Purse seiners*: The purse seines alone accounted for 76.3% of the prawn landings in South Kanara during this period (Fig. 2 A) and the catch amounted to 1,479.3 t (524.6 kg /unit). Out of this, the bulk of the catch was obtained at Mangalore (1,165.2 t and 853.6 kg/unit) forming 78.8% (Fig. 1 A) of the prawn landings by purse seiners in South Kanara. (The estimated prawn catch at Mangalore by purse seiners during 1983–'84 season amounted to 1,244.0 t of which 94% was obtained in September itself). Malpe accounted for 20.7% (306.3 t and 214.9 kg/unit) of the prawn catches (Table 2). Other than 7.8 t (8.8 kg/unit) of prawns landed on 11–9–1983, practically there was no catch of prawns by this gear at Gangolli.

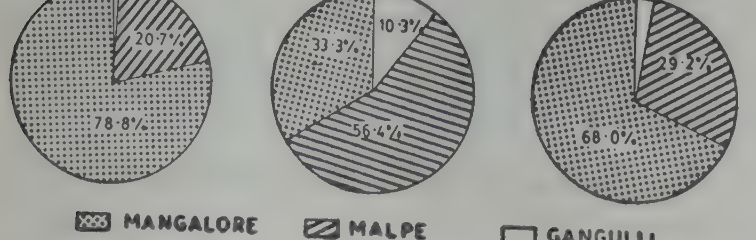


Fig. 1. Percentage contribution of prawns at Mangalore, Malpe and Gangolli (A – Purse seine; B - Trawl; C - All gear).

2*) Shrimp trawlers* : The prawn landing by mechanised trawlers was estimated at 459.7 t (62.9 kg/unit) forming 23.7% of the total prawn landings in South Kanara during the first half of September, 1983 (Table 3, and Fig. 2 A). Out of this, 153.2 t (79.8 kg/unit) were landed at Mangalore forming 33.3% of the prawn catches by this gear (Fig. 1 B). It could be seen that the prawn landings at Malpe was considerably higher than those obtained at Mangalore and Gangolli and accounted for 56.4% (259.2 t and 61.3 kg/unit). At Gangolli, it was comparatively poor than the other two centres and contributed only 10.3% (47.3 t and 40.8 kg/unit) of the prawn landings by this gear.

B. Centre-wise analysis of the prawn landings

1*) Mangalore (Bunder)*: It is seen that the highest catch was realised at Mangalore which contributed 68.0% of the prawn landings in South Kanara during this period (Fig. 1 C). The prawn catch was to the tune of 1,318.4 t (Table 1) of which 88.4% was obtained by purse seiners and the rest by mechanised trawlers (Fig. 2 B).

2*) Malpe (Fisheries Harbour)*: Malpe accounted for 29.2% of the prawn landings (Fig. 1 C) amounting to 565.5 t (Table 1). Of this, purse seiners contributed 54.2 % and the rest by shrimp trawlers (Fig. 2 C).

3*) Gangolli* : Among the three centres under study, the prawn landing at Gangolli was the lowest, being 55.1 t (Table 1) forming only 2.8% of the total prawn landings in South Kanara (Fig. 1 C). Out of this, 85.8% was caught by shrimp trawlers and the rest by purse seiners (Fig. 2 D).

Table 2. *Estimated landings of different category of prawns in tonnes by purse seines at Mangalore, Malpe and Gangolli during the first half of September,* 1983

Centre	No. of units operated	*M. dobsoni*	*P. indicus*	Total	% of prawns in total purse seine catch
Mangalore	1,365	1,139.5	25.7	1,165.2	48.2
Malpe	1,425	297.2	9.1	306.3	4.9
Gangolli	920	7.6	0.2	7.8	not known
Total	3,710	1,446.0	35.0	1,479.3	
%		97.6	2.2		

Table 3. *Estimated landing of different category of prawns in tonnes by shrimp trawlers at Mangalore, Malpe and Gangolli during the first half of September*, 1983

Centre	No. of units operated	*M. dobsoni*	*P. indicus*	*P. monodon*	*P. stylifera*	Total	% of prawns in total trawl catch
Mangalore	1,920	140.8	11.1	—	1.2	153.2	55.2
Malpe	4,225	235.0	11.2	0.3	12.7	259.2	40.5
Gangolli	1,158	19.5	4.3	—	23.5	47.3	not known
Total	7,303	395.3	26.7	0.3	37.4	459.7	
%		86.0	5.8	0.1	8.1		

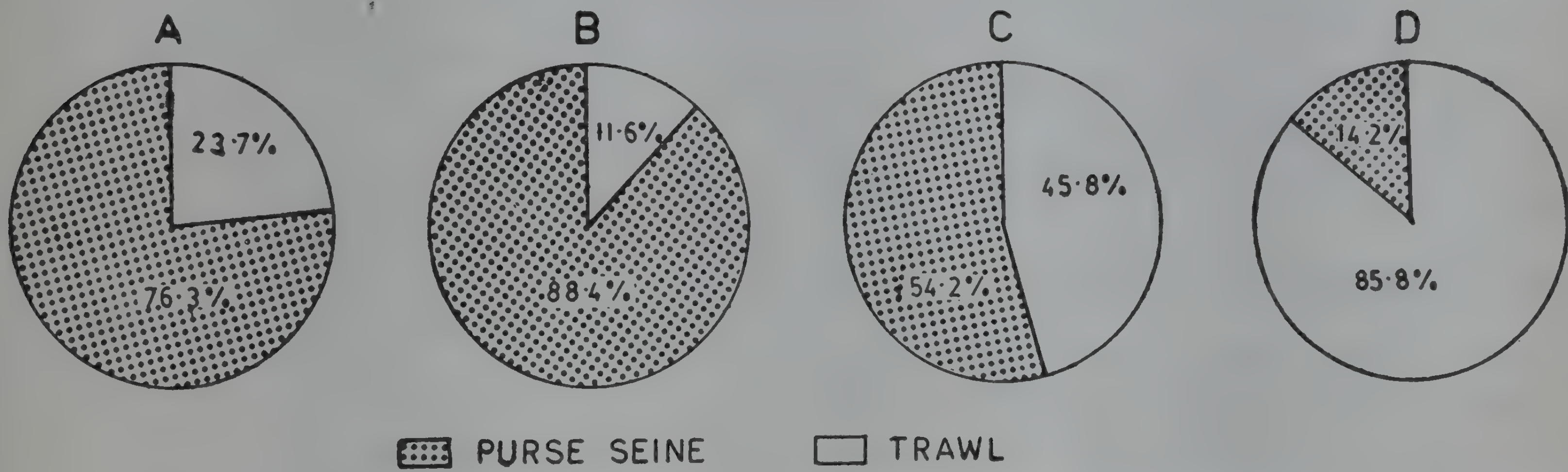


Fig. 2. Distribution pattern of prawns in purse seines and trawls during the first half of September, 1983, (A-South Kanara; B-Mangalore; C-Malpe; D-Gangolli).

C. *Species-wise analysis of the prawn landings*

1) *Species composition of prawns in purse seine catches*: *M. dobsoni* and *Penaeus indicus* were the only two species recorded in the prawn catches by purse seines during this period.

In purse seines, *M. dobsoni* was the most abundant species contributing to the bulk of the prawn catches. It formed 97.6% of the prawn landings in South Kanara by purse seiners (1,446.3 t) (Table 2). The highest catch of this species was obtained at Mangalore (1139.5 t), followed by Malpe (297.2 t). The catch at Gangolli was low (7.6 t).

P. indicus formed 2.2% of the prawn landings by purse seiners (35.0 t). The highest catch of 25.7 t was obtained at Mangalore (Table 2) followed by Malpe (9.1 t). The landing of this species at Gangolli was negligible (0.2 t).

2) *Species composition of prawns in trawl catches*: Unlike in purse seines, the prawn catch by shrimp trawlers was constituted by a number of species. *M. dobsoni* was the chief species as in purse seines, followed by *Parapenaeopsis stylifera, Penaeus indicus* and *P. monodon* in the order of their abundance.

M. dobsoni was the most predominant species forming 86.0% (395.3 t) of the prawn landings by shrimp trawlers (Table 3). It is seen that the best catches of this species by this gear were obtained at Malpe (235.0 t). The landing of this species was 140.8 t and 19.5 t at Mangalore and Gangolli respectively (Table 3).

P. stylifera was the second important species but forming only 8.1% of the prawn landings by trawlers (37.3 t). Maximum catch was recorded at Gagolli (23.5 t) followed by Malpe (12.7 t). This species was poorly represented at Mangalore (1.2 t) (Table 3).

P. indicus formed 5.8% of the prawn landings in South Kanara by shrimp trawlers. The catch was to the tune of 26.7 t of which 11.2 t were landed at Mangalore, 11.2 t at Malpe and the rest (4.3 t) at Gangolli (Table 3).

P. monodon was available only at Malpe on 1-9-1983 (0.3 t) (Table 3).

D. Catch value

Based on the auctioning rates of individual species of prawn in the landing centres on each day of observation, the catch value with respect to prawns has been estimated at Rs. 30.0 million for whole South Kanara during the first half of September, 1983, out of which Mangalore alone accounted for 71.7% (Rs. 21.5 million) (Table 4). The contribution of Malpe towards the total value was only Rs. 7.9 million (26.3%), whereas, that of Gangolli was the lowest being 0.6 million (2.0%).

A gear-wise analysis of the catch value indicated that purse seines alone accounted for 77.7% (Rs. 23.3 million) and the rest (Rs. 6.7 million) by trawlers (Table 4).

Studies on the resources of *M. dobsoni*

Since the prawn fishery was largely supported by *M. dobsoni* during this period, some of its resource characteristics have been studied in detail and an account is given below.

Size distribution

The fishery of *M. dobsoni* was exclusively supported by large sized prawns during this period. At Mangalore, the size ranged from 83 to 108 mm and 93 to 128 mm for males and females with modal sizes at 93 mm and 113 mm respectively in purse seine catches, while, in the trawl catches the size ranged from 83 to 108 mm with mode at 98 mm for males and 93 to 123 mm with mode at 113 mm for females.

At Malpe, the size ranging from 83 to 103 mm and 93 to 123 mm for males and females with modal sizes at 98 mm and 113 mm respectively represented the purse seine fishery, whereas, the trawl fishery was supported by sizes ranging from 83 to 103 mm with mode at 93 mm in males and 78 to 123 mm with mode at 108 mm in females.

The gear-wise size distribution of *M. dobsoni* at Mangalore and Malpe is given in Fig. 3. It is seen that there was no marked difference in the size distribution in different gears except the higher modal sizes noticed in males in the trawl fishery at Mangalore. However, at Malpe, the modal sizes for males and females in trawl catches were small as compared to those of purse seines.

It is interesting to note that *M. dobsoni* was mostly represented by one year class and above during this period, and 0-year class was seldom found in the catch.

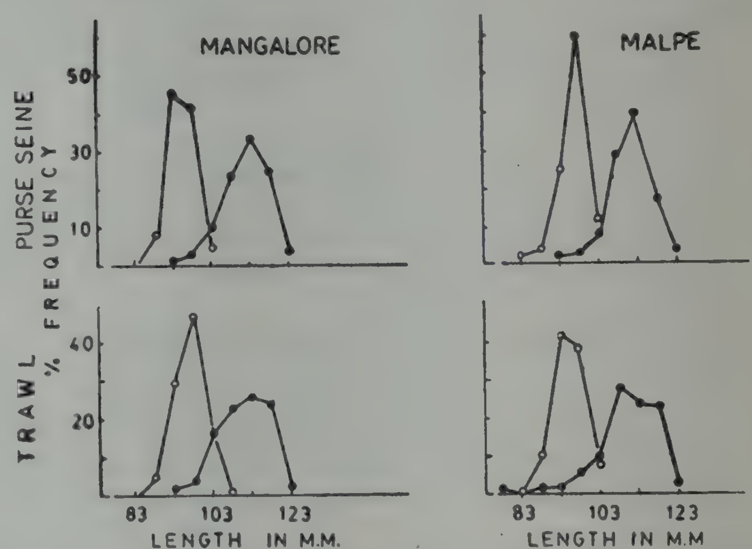


Fig. 3. Size frequency distribution of *M. dobsoni* in purse seines and trawls at Mangalore and Malpe during the first half of September, 1983.
(open circles indicate males and closed circle, females)

Table 4. *Value of prawns landed at Mangalore, Malpe and Gangolli by purse seiners and shrimp trawlers during the first half of September,* 1983 *(in Rupees)*

Centre	Purse seine	Trawl	Total	% of catch value (centre-wise)
Mangalore	1,89,67,820	25,79,270	2,15,47,090	71.7
Malpe	42,69,070	36,77,530	79,46,600	26.3
Gangolli	98,200	4,55,000	5,53,200	2.0
Total	2,33,35,090	67,11,800	3,00,46,890	
% of value (gear-wise)	77.7	22.3		

Centre-wise age composition data is given in Table 5 which indicated that 95 to 97% was comprised by one year olds, 2 to 3% by two year olds and 1 or less than 1% by O-year prawns. It is seen that there was not much difference in the age structure of *M. dobsoni* in trawls and purse seines at these centres.

Table 5. *Age composition* of M. dobsoni (in percentage) in purse seines and trawls at Mangalore and Malpe during the first half of September,* 1983

	Mangalore			Malpe		
	0-year	1-year	2-year	0-year	1-year	2-year
PURSE SEINE						
Males	0.4	99.3	0.3	0.7	99.3	—
Females	1.1	95.0	3.9	1.2	95.2	3.6
TRAWL						
Males	0.2	98.9	0.9	0.4	99.6	—
Females	1.6	95.6	3.4	5.5	92.1	12.4

* Males up to 85 mm, 86 - 105 mm and above 106 mm; Females upto 95 mm, 96 - 120 mm and above 121 mm for 0 - year, 1 - year and 2 - year classes respectively.

Sex ratio

The sex ratio in percentage in respect of *M. dobsoni* for purse seines and trawls at Mangalore and Malpe is given in Table 6. It could be seen that males and females were distributed more or less equal in trawl catches at Mangalore and Malpe, whereas, females dominated in purse seines at these centres (61.8 and 82.0% respectively). The preponderance of females in higher proportions in purse seine catches may be attributed to the behavioural pattern of females to come out of the bottom layers during night, possibly for spawning, which in turn was removed by purse seines in the early hours of the day. This is further supported by the fact that a purse seine sample of 100 prawns collected from Mangalore on 1–9–1983 had only two males and the rest were all females.

Table 6. *Sex ratio distribution (in percentage) of M. dobsoni in purse seines and shrimp trawlers at Mangalore and Malpe during the first half of September,* 1983

Sex	Mangalore Purse seine	Mangalore Trawl	Malpe Purse seine	Malpe Trawl
Males	38.2	49.0	18.0	47.1
Females	61.8	51.0	82.0	52.9

Maturity

In *M. dobsini,* spent and spent recovering females were noticed fairly in large quantities (Table 7). In addition, mature and impregnated females were also found in considerable numbers at both centres. All these suggested peak spawning in this species during this period. The maturity distribution in purse seine and trawl at these centres showed more or less a similar pattern.

Table 7. *Distribution of various maturity stages of M. dobsoni in purse seines and trawlers at Mangalore and Malpe during the first half of September,* 1983 *(figures denote percentage)*

Maturity stages	Mangalore Purse seine	Mangalore Trawl	Malpe Purse seine	Malpe Trawl
Immature	15.9	18.6	15.9	27.1
Maturing early	15.4	17.0	3.5	10.1
Maturing late	18.1	10.5	4.5	19.0
Mature	8.7	6.5	9.7	11.8
Spent/spent-recovering	41.9	47.4	66.4	32.1
Impregnated	35.4	23.0	25.7	30.2

Soft-prawns

It is seen that in a sample analysed on 7–9–1983, 46.9% of females was in soft condition and the rest with hard shells. (similar data for the other days not available). It is interesting to note that practically all males were with hard shells. The presence of soft females in fairly large numbers indicated that females might have underwent moulting probably after spawning. This conclusion is based on the occurrence of large number of spent and spent recovering females during this period (Table 7). This also suggested that males might have undergone moulting first and females at a subsequent period as recorded in other crustacens. By the time the females underwent moulting and become soft, the males might have hardened their shells and were ready for impregnation. The occurrence of good number of impregnated females also supported this view (Table 7).

Survival rate, S and the total instantaneous mortality coefficient, Z

Since the fishery of *M. dobsoni* during the first half of September, 1983 was supported largely by one year

class and above, which were fully recruited age groups, the survival rate, S, was calculated based on the age composition data of this prawn by employing the formula,

$$S = n_2/n_1$$

where, the n1 and n2 are the numbei of prawns per unit of effort in the same fishing season in different age groups, ie., 1 year and 2 year olds respectively. From the S value, the total instantaneous mortality coefficient, Z, could be obtained by the relation,

$$S = e^{-Z}$$

This can be rewritten in the following form,

$$-Z = \log_e S$$

$$Z = -\log_e S$$

It is seen that the Z values for purse seines and trawls at Mangalore were 3.64 and 3.80, while these values for Malpe were 3.47 and 4.34 respectively (Table 8).

Table 8. *Age composition (c.p.u.e. in numbers), survival rate, S, and instantaneous total mortality coefficient, Z of M. dobsoni in purse seines and trawls at Mangalore and Malpe during the first half of September,* 1983

	Mangalore		Malpe	
	Purse seine	Trawl	Purse seine	Trawl
1-year	49,775	7,272	11,226	5,707
2-year	1,301	162	46	74
S	0.026	0.022	0.031	0.013
Z	3.64	3.80	3.47	4.34

It could be seen that there is not much variation in the Z values of purse seines and trawls of these centres. These values also indicated that this prawn was heavily exploited during this period.

Conclusion

Even before the advent of purse seiners there was fairly good catches of prawns by shrimp trawlers in September atleast during some years. But the introduction of purse seines has resulted in bumper catches of *M. dobsoni* in September, when the fishing season commenced. Though purse seines were introduced with an intention to exploit the vast pelagic resources available along the Karnataka coast, its contribution towards the exploitation of Prawn of this area, has been considerably high, atleast in September. It is a fact that 76% of the prawn catch during the first half of September, 1983 was obtained by purse seines, whereas, the shrimp trawlers which are supposed to be the principal gear for exploiting the prawn resources, could contribute only 24% of the prawn landings during this period. The unprecedented catch of prawns in purse seines might possibly be due to the fact that the resource of *M.dobsoni* was found to be very close to the shore. Moreover, the behavioural pattern of females to come off the bottom for spawning and remain in the column waters for considerable amount of time as they were fully exhausted, might have helped the mechanised fishery, particularly purse seiners, to exploit them heavily. The huge size of the purse seine nets helped to encircle large areas and fish the 'accumulated stock' resulted out of the closed season (June–August) due to monsoon.

The heavy catches of *M. dobsoni* in September after the closed season revealed some interesting facts and suggested the following.

i) The closed season helps in replenishment of the resources.
ii) It results in the accumulation of stock.
iii) It provides sufficient protection for younger prawns to feed and grow to larger sizes.
iv) The closed season is a natural way of conservation of the resources and results in better yields in a short period, than during the regular fishing season.

The most striking feature was that the fishery of *M. dobsoni* during this period, was exclusively consisted of larger sizes. (On the other hand, the purse seine fishery during January–February, 1984 was supported by relatively smaller sized prawns of this species with modal sizes at 73 mm and 93 mm as against the present 98 mm and 113 mm respectively obtained for males and females.

This species was heavily exploited by purse seines and trawlers resulting in unprecedented catches during the first half of September, 1983. It is pertinent to ask whether this has any adverse effect on the resource. Generally, when a resource is subjected to heavy exploitation by different types of gears, it may lead to the depletion of the resource. Although there has been wide fluctuations in the catch of *M. dobsoni* in September, during various seasons, the present studies indicated that the intensive fishing during September may not lead to any conservatory problems. These prawns have already reached their maximum size (prawns larger than

the presently reported ones have not been recorded any time in the fishery) and hence in the fag end of their life. In addition, they might have spawned atleast three to four times before they attained the present size. It is reasonable to assume that they may possibly die of natural mortality if not exploited at that size. This has been further supported by the occurrence of dead and decayed prawns in trawl catches during this period, as well as the large scale occurrence of shells of dead prawns along the beaches of this region towards the fag end of the monsoon season. Therefore, it is not likely to pose any serious conservatory problem, atleast in the near future. However, a close monitoring of the situation is essential.

The author is extremely thankful to Dr. E.G. Silas, former Director, Central Marine Fisheries Research Institute, Cochin, for his guidance and keen interest shown throughout the course of this investigation. Thanks are also due to Dr. M. J. George for critical reading of the manuscript and suggesting improvements.

NIGHT TRAWLING FOR PRAWNS AT MANGALORE ENCOURAGING*

Introduction

Exploitation of prawn resources by mechanised trawling has been intensified since the beginning of seventies due to the ever-increasing demand for prawns for export. Even among prawns, there has been greater demand for larger varieties since they fetch very high price. This is prompting more and more entrepreneurs to go in for different types of fishing for catching large sized prawns. Trawl fishing during night time is one such method at present adopted by trawler owners of Mangalore area and this has been found to yield promising results. Since there is considerable disparity in effort, catch and catch composition of prawns of day and night boats, an appraisal of the trawl fishery has been attempted here with special reference to day and night fishing, based on the data collected from Mangalore during the fishing season, 1982–83.

Fishing operations

The crafts and gears employed in trawl fishery along South Kanara coast have been mentioned by Sukumaran *et al. (Mar. Fish. Infor. Serv. T & E Ser., No.* **44**: 1982).

The trawling season generally starts in September and continues up to May end or early June. During 1982–'83, however, the fishery lasted up to the middle of June. Fishing operations will remain suspended during the southwest monsoon period.

Generally, trawlers set out for fishing in the early morning and return by afternoon, sometimes landing even up to 15 or 16 hrs. The boats engaged in day fishing are comparatively smaller in size (less than 9.75 m) and usually fish within 25 m depth zone. These units make 1 to 3 hauls per day, each lasting 2 – 3 hours. Apart from these vessels, there are a good number of larger boats (above 9.75 m) engaged in night fishing, upto a depth zone of 55 m. These units generally set out for fishing in the evening and return after 1–2 days' night fishing. These night units usually make 2 hauls per night, each lasting 4 to 5 hours. In order to keep the prawns and quality fishes in good condition, these boats generally carry 2–3 large ice boxes.

Around 415 trawl units are operating from Mangalore (Bunder). Not less than 40 purse seine boats were also found to engage in night trawling since the pelagic fishery failed during this season. In addition, a good number of shrimp trawlers belonging to neighbouring centres also operated from this centre during certain period of the year.

*Prepared by K. K. Sukumaran, Mangalore Research Centre of CMFRI, Mangalore.

Since there was considerable disparity in effort, catch and catch composition of prawns in day and night landings, the study was made under two broad headings namely, night fishing for prawns and day fishing for prawns.

Night fishing for prawns

Effort

Night fishing started in the middle of November and continued up to May, with a peak in April, 1983 (Fig. 1). Altogether, 9,221 units were operated for night fishing with maximum in March, 1983. The night units formed around 20% of the total trawl units operated from Mangalore during 1982–'83 (Fig. 2 A). If the efforts in actual fishing hours were taken into consideration, altogether 90,569 hours were spent in night fishing with maximum in April, 1983 (20,580 hrs). Out of the annual effort in hours (2,71,230 hrs), night fishing accounted for 33.4% (Fig. 2 B).

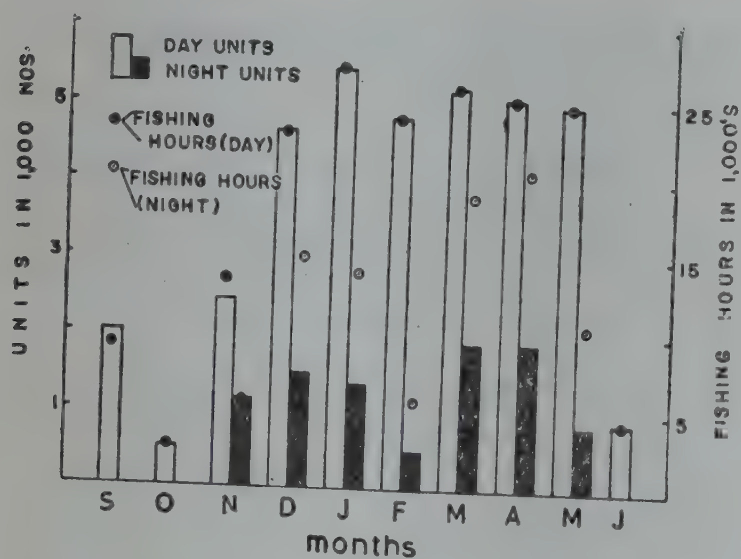


Fig. 1. The distribution of fishing effort in various months at Mangalore during 1982–'83.

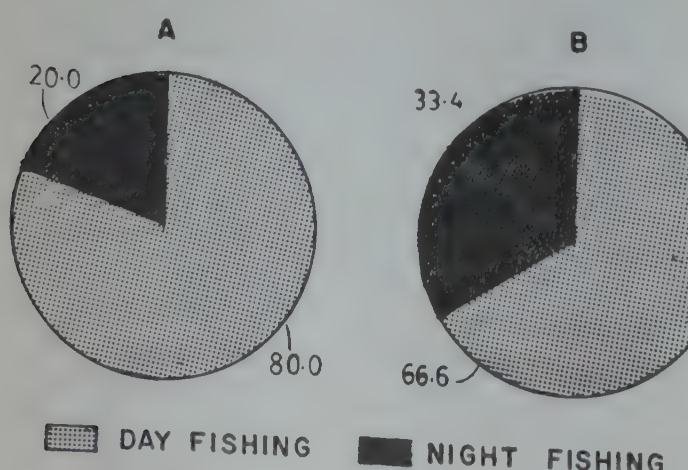


Fig. 2. The distribution pattern of annual fishing effort for day and night trawling at Mangalore during 1982–83. A- fishing trips; B-Actual trawling hours.

Catch and catch composition

In the annual trawl landings during 1982-'83, night fishing contributed around 36% (Fig. 6 B). The trawl catch can be divided into two groups, ie., prawns and by-catches.

The annual prawn catch amounted to 331.0 t (3.6 kg/hr) which formed 9.8% of the trawl landings by night fishing (3,389.2 t) at Mangalore during this period (Fig. 3 B). Though maximum effort was expended in March and April, 1983, the highest catch was obtained in December, 1982 (79.4 t) (Fig. 4). The prawn catch was low in November, 1982 and February, 1983.

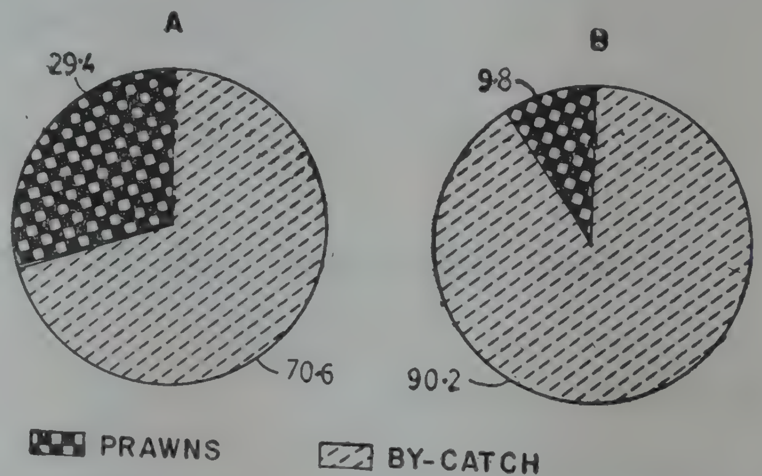


Fig. 3. Distribution pattern of prawns and by-catches in the shrimp trawlers at Mangalore during 1982–'83. A - Day catch; B-Night catch.

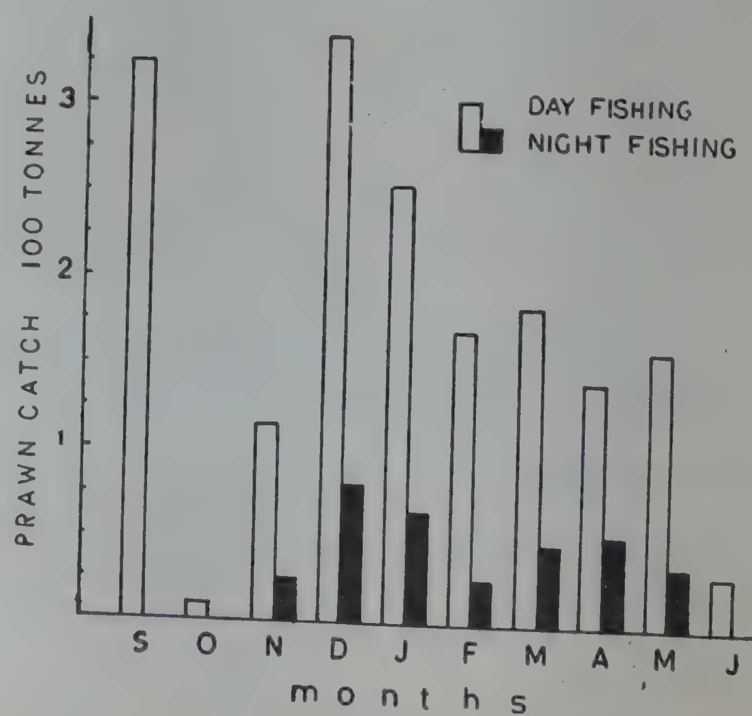


Fig. 4. Prawn landings by day and night trawling in various months at Mangalore during 1982–'83.

The prawn catch was composed of larger species, such as, *Metapenaeus monoceros, Penaeus indicus, P. monodon* and *M. affinis* in the order of their abundance. The percentage composition of different category of prawns is given in Fig. 5 A.

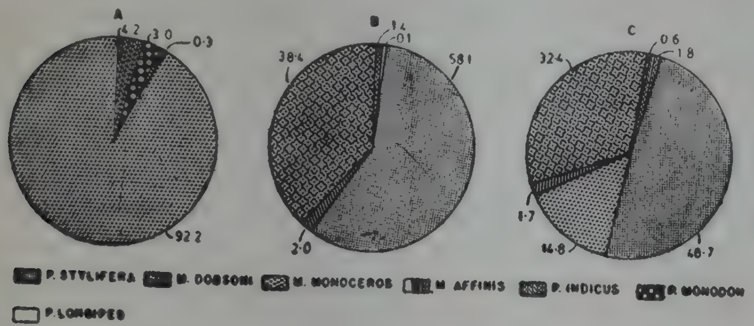


Fig. 5. Species composition of prawns landed by shrimp trawlers at Mangalore during 1982–'83. A-Night catch; B-Day catch; and C-Day and night catch combined.

M. monoceros ('brown shrimp'): This prawn formed the bulk of the prawn catch (92.2%) by night boats, and the catch amounted to 305.9 t with a catch rate of 3.4 kg/hr for the whole season. Landings of this prawn was fairly high during December–January (Table 1).

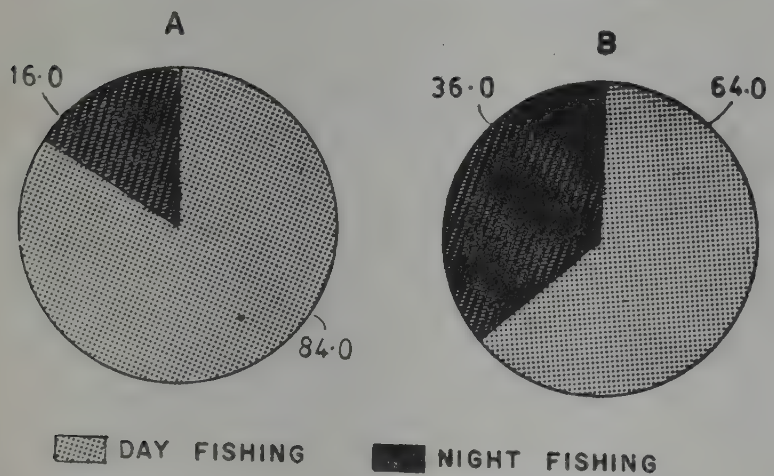


Fig. 6. Distribution pattern of prawns and total trawl landings by night fishing and day fishing at Mangalore during 1982–'83. A-Prawn landings; B-Total trawl landings.

P. indicus ('white shrimp'): This species contributed 4.2% of the prawn landings by night fishing, and the annual catch was 14.0 t (0.2 kg/hr). Maximum landings were obtained in January and May, 1983 (Table 1).

P. monodon ('tiger prawn'): It formed 3% and the catch amounted to 10.1 t (0.1 kg/hr). Maximum catch was obtained in April, 1983 (Table 1).

M. affinis ('brown shrimp'): The catch of this prawn was low (1.0 t), and contributed only 0.3% of the annual prawn landings by night fishing. Catches were recorded in November, 1982 and February, 1983 only (Table 1).

In addition to prawns, fairly large quantities of by-catches were also landed regularly by night fishing. These mainly included fishes (of different category), stomatopods, crabs, cephalopods and trash fish. A detailed account of the different fish groups of the by-catches landed by trawls in South Kanara has been given by Sukumaran *et al.* (1982). The catch details of these fish groups during 1982–'83 are also incorporated in Table 1 which show that quality fishes and trash fish together formed the bulk of the night catch.

Day fishing for prawns

Effort

During 1982–'83, altogether 36,330 units were operated for day fishing with maximum in January, 1983

Table 1. *Estimated monthwise landings (in tonnes) of different category of prawns and by-catches by night trawlers at Mangalore during 1982–'83*

Species/category	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Total
M. monoceros	24.4	75.4	61.3	23.7	43.5	46.1	31.5	305.9
M. affinis	0.2	—	—	0.8	—	—	—	1.0
P. indicus	0.2	2.5	3.5	0.7	2.1	3.5	1.5	14.0
P. monodon	0.3	1.5	1.0	1.0	2.0	2.5	1.8	10.1
Total prawns	25.1	79.4	65.8	26.2	47.6	52.1	34.8	331.0
Fishes	220.4	265.7	295.2	68.6	273.3	293.1	170.1	1586.4
Stomatopods	—	42.1	52.1	8.0	141.7	24.3	—	268.2
Cephalopods	17.7	12.0	5.5	6.0	13.6	18.0	2.5	75.3
Trash fish	—	179.3	174.9	90.4	266.6	301.3	115.8	1128.3
Monthly total	263.2	578.5	593.5	199.2	742.6	688.9	323.2	3389.2

(5,473 units) (Fig. 1). The day units formed around 80% of the total effort expended for trawling during this period (Fig. 2 A). Out of the 2,71,230 hours of trawling, day fishing alone accounted for 1,80,661 hours (66.6%) (Fig. 2 B).

Catch and catch composition

In the annual trawl landings, day fishing alone contributed about 64%. The prawns formed 29.4% of the trawl landings by day fishing (Fig. 3 A), amounting to 1,736.8 t (9.6 kg/hr) (Table 2). Although maximum effort was expended in January, 1983, the best catches were obtained in December, 1982 (339.8 t) followed by September, 1982 (326.2 t) (Fig. 4). As usual, the prawn catch was low in October, 1982.

It is interesting to note that the species composition of prawns in the day catches was quite different from night catches. The percentage composition of different category of prawns in day catches is given in Fig. 5 B.

P. stylifera ('karikadi'): This was the chief species, contributing to 58.1% of the prawn landings by day fishing. The annual catch amounted to 1,004.5 t (5.1 kg/hr). This species was available throughout the season except September, and the maximum landings were recorded in December, 1982 (294.0 t) (Table 2).

M. dobsoni ('poovalan'): This prawn was the second important species forming 38.4% of the prawn landings, and the annual catch amounted to 667.7 t (3.7 kg/hr). The highest catch was recorded in September, 1982 (310.8 t) when the season started, and nil catch in October, 1982 (Table 2).

M. affinis: The catch of this species was only 34.7 t (0.2 kg/hr) forming 2% of the annual landings by day fishing. The maximum landings were recorded in April, 1983 (11.3 kg/hr) (Table 2).

P. indicus: The annual catch amounted to 23.5 t (0.1 kg/hr) forming 1.4% of the prawn landings by day fishing for the whole season. The catches were fairly good in the first week of September, 1982 when the fishery commenced (Table 2).

P. monodon: The landings of this prawn was negligible (0.1 t).

Parapenaeus longipes: This species was caught only in May, 1983 and the catch amounted to 1.8 t (0.1%).

In addition, prawns like, *Trachypenaeus curvirostris, Metapenaeus moyebi, Parapenaeopsis acclivirostris, Solenocera crassicornis, Nematopalaemon tenuipes* and *Exhippolysmata ensirostris* also occurred in stray numbers.

By-catches included fishes, stomatopods, crabs and cephalopods, and are described by Sukumaran *et al.* (1982). Details of the by-catches are given in Table 2.

Table 2. *Estimated month-wise landings (in tonnes) of different category of prawns and by-catches by day trawlers at Mangalore during* 1982–'83

Species/category	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total
M. dobsoni	320.8	—	21.5	45.8	80.8	84.4	44.2	33.2	43.0	4.0	667.7
M. affinis	—	0.2	0.2	—	0.1	3.0	6.5	11.3	9.6	3.8	34.7
P. stylifera	—	9.9	92.7	294.0	173.0	81.0	133.5	94.2	102.1	24.1	1004.5
P. indicus	15.4	—	0.2	—	0.2	0.9	0.4	3.9	2.3	0.2	23.5
P. monodon	—	—	0.1	—	—				—	—	0.1
P. longipes	—	—	—	—	—	—	—	—	1.8	—	1.8
Total prawns	326.2	10.1	114.7	339.8	254.1	169.3	184.6	142.6	158.8	32.1	1732.3
Fishes	122.1	69.4	222.2	291.9	379.4	378.6	225.0	279.2	469.1	46.6	2483.5
Stomatopods	—	—	8.2	223.9	259.1	417.1	362.9	134.3	102.5	4.6	1512.6
Crabs	—	—	—	3.6	47.3	32.6	13.4	30.3	15.6	1.5	144.3
Cephalopods	—	—	2.2	—	5.7	3.0	0.8	17.0	5.3	—	34.0
Monthly total	448.3	79.5	347.3	859.2	945.6	1000.6	786.7	603.4	751.3	84.8	5906.7

Annual prawn landings

The annual prawn landings by trawl fishery, when day and night catches were put together, amounted to 2,063.3 t (7.6 kg/hr), which formed 21.9% of the annual trawl landings during 1982-'83 (Fig. 7). It is seen that 84% of the prawn catch was contributed by day fishing and the remaining by night fishing (Fig. 6 A). Though prawns landed throughout the season, the highest catches were recorded in December, 1982 (Fig. 8). Taking an overall picture of the day and night fishing, *P. stylifera* was the most abundant species contributing 48.7% followed by *M. dobsoni* (32.4%), *M. monoceros* (14.8%), *P. indicus* (1.8%), *P. monodon* (0.6%) and *M. affinis* (1.7%) (Fig. 5 C).

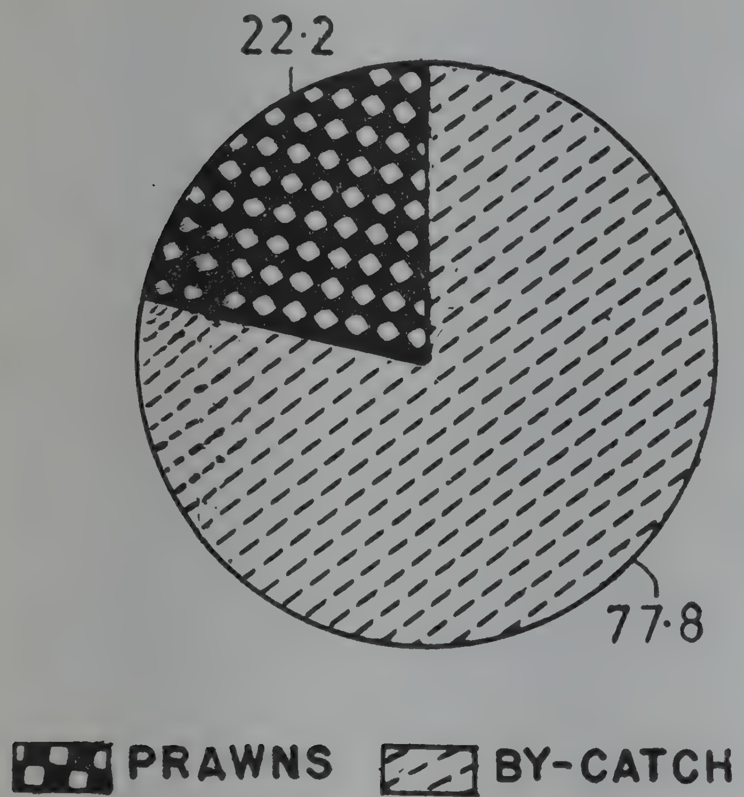


Fig. 7. Distribution pattern of prawns and by-catches in shrimp trawlers at Mangalore 1982–'83.

Annual income

Based on the auctioning rates of individual species of prawns (average) and by-catches during different months at the landing centre, the gross income for 1982-'83 has been calculated to Rs. 30.0 million, out of which Rs. 15.6 million (51.9%) was obtained from night fishing and the rest from day fishing (Fig. 9 B). Out of the gross income, prawns alone accounted for 26.3 million forming 87% of the return (Fig. 9 C) of which night fishing contributed Rs. 13.4 million (50.8%) and the rest from day fishing. Thus, although night fishing contributed only 16% of the annual prawn catch, the income from sale proceeds was more than that obtained from day fishing (Fig. 9 A).

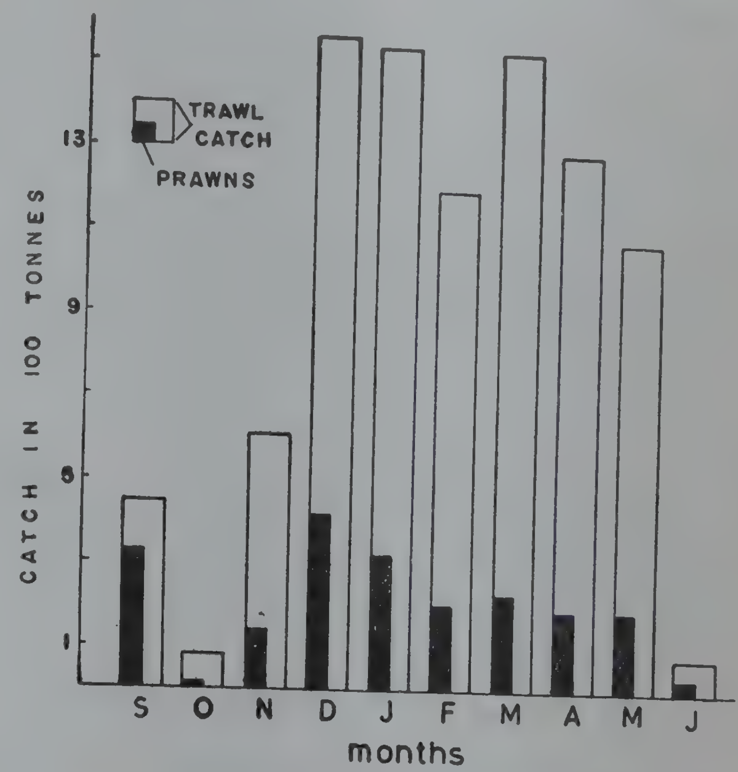


Fig. 8. Monthwise prawn catch and total trawl landings at Mangalore during 1982-'83.

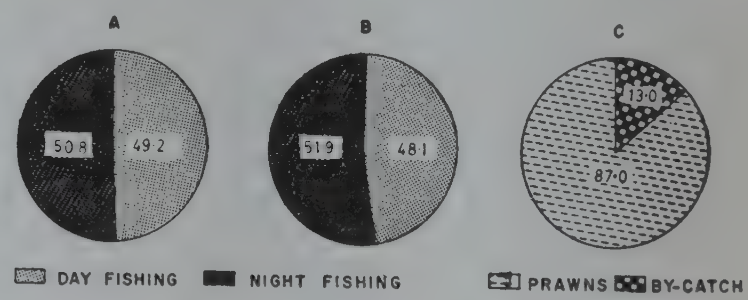


Fig. 9. Annual income of shrimp trawlers at Mangalore during 1982–'83. A-Income from prawns; B-Income from day and night catch; and C-Income from prawns and by-catches.

From this data, the average income per trip has been worked out for day and night fishing units separately for 1982–'83. It is seen that the average income per trip was Rs. 397.00 and Rs. 1,690.00 for day (average 5 hrs fishing) and night fishing boats (average 10 hrs fishing) respectively.

Discussion

Despite increased effort the mechanised prawn fishery at Mangalore declined year after year during the latter half of seventies, and the prawn catch was the lowest during 1980–'81 (675.7 t). As compared to a moderate catch of 984.6 t during 1981–'82, the following year (1982–'83) witnessed a record catch of 2,063.3 t (this is exclusive of 449.0 t of prawns landed by purse

seiners). The prawn landings increased by 110% during 1982–'83 as compared to the previous season along with substantial increase in effort during this season (effort increased by 33% in units and 76% in actual fishing hours). This is mostly brought about by the increased operation of the vessels for night fishing.

As regards income also, there has been considerable increase, The gross income has increased from Rs. 21.3 million during 1981–'82 (Sukumaran *et al.*, 1982) to Rs. 30.0 million during 1982–'83. Out of this, prawns alone accounted for 87% of the value, although it formed only 22% of the trawl landings.

The present studies also indicated that the average income per day of night fishing boats was considerably higher than that obtained by day units, thereby suggesting that night fishing was more profitable. The addition of more and more boats for night fishing in the recent years also point to the profitability of night operations in comparison with day operations.

OCCURRENCE OF MATURING FEMALES OF KURUMA PRAWN, *PENAEUS JAPONICUS* IN THE MARICULTURE FARM AT MUTTUKADU*

In December, 1983 about 2,000 numbers of seed of *Penaeus japonicus* (average size: 42.2 mm) collected from wild were stocked in a 0.4 ha pond (No. A–4) at the Mariculture Farm, Muttukadu, Madras. Though supplementary feed was provided, the growth of stocked prawns was not appreciable and in a period of six months the prawns attained an average size of 109.7 mm only. Even after repeated drag netting during the night hours, complete stock could not be harvested, as the species was known for its burrowing habit. In the following months, few individuals were seen moving along the inner edge of the pond A–4, during the night hours.

On 10–11–1984, six hauls by drag net were made in Pond A–4 between 21.30 and 22.30 hrs which yielded 23 larger specimens. Among the netted prawns, 11 were males and the rest 12 were females. The size range for males and females was 140 to 158 mm (20 to 31 g in weight) and 156 to 174 mm (32 to 48 g in weight) respectively. The average size for males was 152.0 mm and that of females 159.2 mm. All the males were mature, as the white mass was seen at the base of fifth walking legs. In the case of females, all the specimens were found to have developing ovaries, when they were seen against the light. By judging from the width of the ovary seen, most of the prawns could be placed in stage I and II of ovarian development. A specimen measuring 163 mm in total length was dissected out to examine the status of ovary. The anterior and middle portions of the ovary were cut and preserved in Bouin's fluid and buffered formalin for histological studies.

Plankton hauls were made inside the pond A–4 in the early hours on 11–11–1984 to look for prawn larvae. The analysis of plankton indicated only the presence of mysids (dominant item), small medusae, copepods and copepodites and larvae and adults of the fish, *Allanetta forskali*.

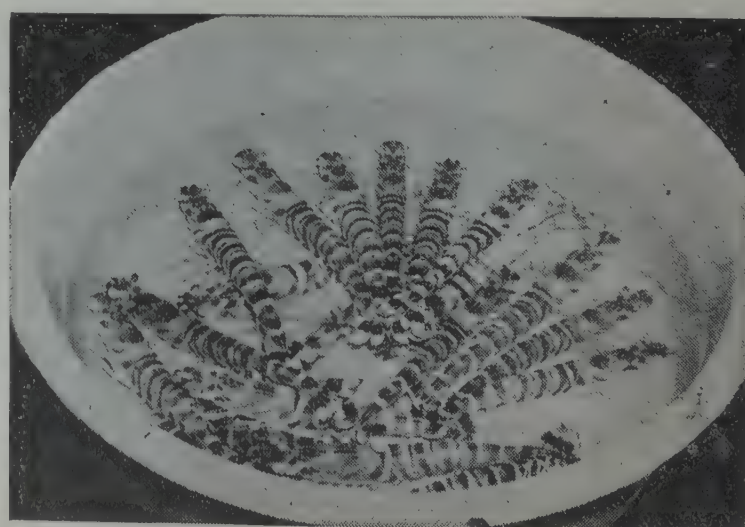


Fig. 1. Female kuruma prawns matured in Muttukad Fish Farm, Madras.

*Prepared by M. Kathirvel, Madras Research Centre of CMFRI Madras.

All the specimens were transported alive by bicycle to Kovalam Field Laboratory on the night of 10th November itself and placed in two half-tonne pools having sandy bottom. The salinity of the water used was 26.0‰. Figs. 1, 2 and 3 show the photographs of the larger specimens of *P. japonicus,* the dissected out specimen and the prawns with various developmental stages of ovary.

Later a total of 10 prawns (7 females and 3 males) were housed in a one-tonne fibre glass tank having a sandy bottom and sea water of 30‰ over which illumination by a pair of tube light was provided as a means to induce further ovarian development. The capture and subsequent transfer to the laboratory tanks resulted in the absorption of ovary in some of the specimens. Artificial illumination for a period of 14 hr/day was given to induce the growth of the ovary.

In the night of 17–11–1984 another attempt was made to obtain more specimens of kuruma prawn by drag netting and this resulted in the collection of three females; one with developing ovary (TL 180 mm; CL 49 mm) and the other two with impregnation. They were put along with those stocked earlier in the pools for carrying out unilateral eye stalk ablation.

The salinity (‰) of surface water recorded in pond A–4 where the field culture of *P. japonicus* took

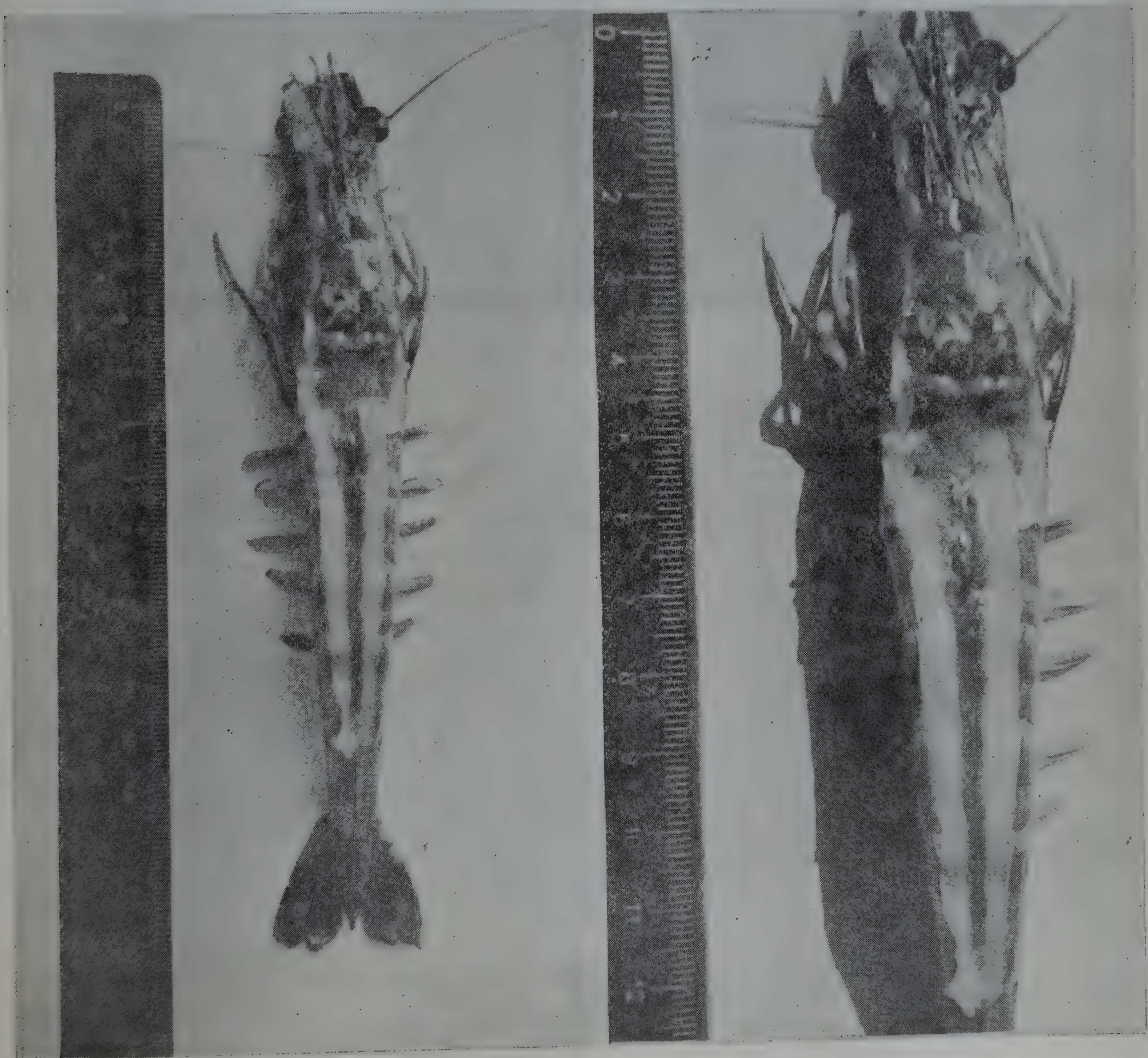


Fig. 2. Dorsal view of ovary from a sacrifised specimen and close-up view of ovary.

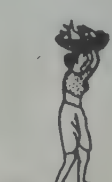
Fig. 3. *Penaeus japonicus* - Females with various stages of ovarian-development.

place during December, 1983 to October, 1984 is given below.

Month	Minimum	Maximum	Average
December '83	16.92	17.86	16.07
January '84	14.58	19.83	16.26
February	13.68	15.19	13.68
March	15.19	18.68	17.49
April	19.17	24.99	24.92
May	25.92	29.23	28.76
June	25.74	28.15	30.79
July	28.64	31.08	28.57
August	29.64	33.39	30.39
September	26.43	31.08	29.46
October	18.76	25.16	21.87
November 10th: 20.12‰			
*November 14th: 14.00‰			

*After heavy rains during 12–13th November.

It has been observed that the salinity in pond A–4 gradually raised from March '84 onwards and reached the peak during June–August and afterwards it lowered. The values of the salinity at the bottom of the pond are likely to be more, perhaps by one or two parts than at the surfaces. Earlier records of maturing/matured penaeid prawns of India in low saline waters include *Metapenaeus dobsoni* from open backwaters of Cochin and perennial culture fields of Vypeen Islands, Kerala and *Metapenaeus moyebi* from Pulicat Lake on the Madras coast. The present observation enlists *Penaeus japonicus* with those prawns attaining maturity in low saline waters, or to say precisely in confined waters.



AN UNUSUAL BUMBER CATCH OF WHITE PRAWN, *PENAEUS INDICUS* FROM KOVALAM BAY NEAR MADRAS*

Introduction

In the history of the fishing village, namely, Kovalam (lat. 12°47′N long. 80°15′E), formerly known as Covelong, situated 35 km south of Madras City, heavy landings of the Indian white prawn, *Penaeus indicus* caught with gill net have occurred for the first time during 16th–20th December, 1984. The inshore sea off Kovalam is a cove or a small bay, from which the village's name could have been derived as 'Covelong' (Fig. 1). The bottom of the bay is rocky covered by sand to a height of about 1m and there are a number of projected rocks scattered around the bay which prevent trawling in this ground. Usually, prawns are caught by the traditional gill net (single layer) during the post monsoon months (January–June) and the catch composed of larger-sized (150 to 180 mm) white prawns and rarely tiger prawns (*P. monodon*) of 190 to 250 mm. From April, 1984 onwards, sporadic fishing with the newly introduced 'Trammel net' was carried out. In this net, there are three layers, the middle one having smaller mesh (45 mm) and outer layers with larger mesh (400 mm). Unlike the traditional gill net locally known as 'Aravalai' (45 mm mesh size), the bottom of the trammel net has lead as weights at regular intervals of 15 cm, so that the net can get buried to a depth of 10 cm in the silt-sand bottom of the fishing ground. The overall length and breadth of this three-layered net is 120 to 200 m and 2.5 to 3.0 m respectively. This net is locally called as 'Mani valai.'

Fishing

It all started on 16-12-1984 when 50 units of catamaran belonging to Kovalam, Karikkattukuppam and Chemenjeri engaged in operation of trammel nets from 0600 to 1600 hrs landed white prawns at a rate of 2 to 8 kg per unit. The news of gill netting of white prawns spread to the nearby fishing villages and also as far as Thevanampatnam, north of Cuddalore (about 121 km south of Kovalam) which resulted in large scale

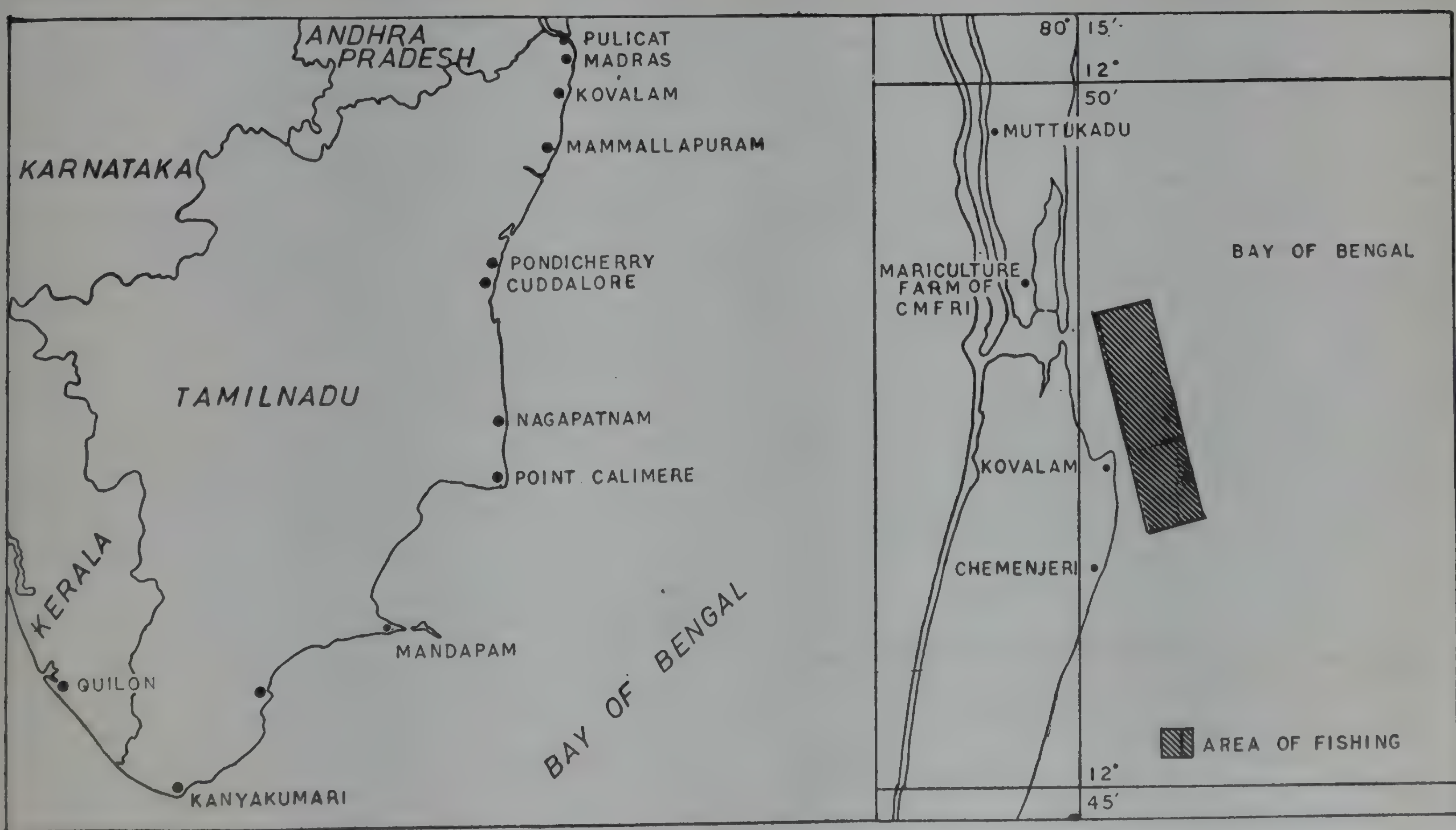


Fig. 1. Map showing Tamilnadu coast and Kovalam Bay.

*Prepared by M. Kathirvel, V. Selvaraj, A. Ramakrishnan, S. Palanichamy, K. Shahul Hameed, P. Poovannan and M. Bose, Madras Research Centre of CMFRI, Madras.

gill net operations by hundreds of catamarans for four days, from 17th to 20th December, 1984. The landings of white prawn were examined randomly to assess the overall catch. Date-wise particulars of units operated, estimated catch and catch per unit are given below.

Date	No. of units operated	Estimated catch (in tonnes)	Catch (kg) per unit (range)
16–12–'84	50	0.250	2 to 8
17–12–'84	300	4.620	5 to 30
18–12–'84	560	7.448	7 to 25
19–12–'84	412	1.160	1 to 8
20–12–'84	60	0.200	¼ to 5
Total	1382	13.678	¼ to 30

On the sixth day (21–12–'84), 45 units of trammel nets were operated at Kovalam but there was virtually no landing of prawns.

Suspecting a southerly migration of prawns, enquiries were made in different fishing villages between Kovalam and Mammallapuram (formerly known as Mahabalipuram). It was learnt from the fishermen of Devanerikuppam (15 km south of Kovalam) and Mammallapuram (18 km south of Kovalam) that heavy landings of *P. indicus* ranging from 10 to 30 kg per unit occurred on 20–12–'84 and 21–12–'84. When the fishermen at Nochikuppam (30 km north of Kovalam) were contacted, it was learnt that fishing by trammel net for *P. indicus* was intensified during 11th to 15th December, '84, as the return of catch was heavy. All these fishermen expressed their opinion that white prawns were moving southerly, close to the coast, taking advantage of the prevailing southerly wind and current.

Photograph No. 1. Landing of white prawns by cattamarans at Kovalam, Madras.

In this heavy fishing at Kovalam, fishermen from Thevanampatnam (121 km south of Kovalam) to Royapuram (northern part of Madras city) participated. They transported their catamarans by lorries to Kovalam. The news of white prawn catch was conveyed even to the far off fishermen through postal communication by their friends and relatives from Kovalam and nearby villages.

Photograph No. 2. A heap of prawns caught from Kovalam Bay near Madras.

Analysis of random samples

Random samples were collected on 2nd (17th Dec.), 4th (19th Dec.) and 5th (20th Dec.) day of fishing for biological observations. The catch was exclusively composed of *Penaeus indicus* and stray specimens of *Metapenaeus dobsoni* and few fishes like carangids and sciaenids. The sex-wise size distribution of *P. indicus* on the sampling days is given in Fig. 2. The overall size range for *P. indicus* was between 99 and 160 mm. In the second day of fishing (17–12–'84), the dominant size group observed for male and female was 116–120 mm and 126-130 mm respectively, which was seen at 126–130 mm for both sexes on 4th day (19–12–'84) of fishing. However, the dominant size was reduced to 121–125 mm for both sexes on the final day of fishing (20–12–'84). Among the sexes, females dominated during 2nd and 5th days of fishing, while males were more in number on 4th day of netting. Female specimens above 125 mm showed either spent or early maturing stage. Fully matured females were rare in the catch. On the contrary, few female specimens of *M. dobsoni* encountered were either impregnated or fully matured or both. The size range for *M. dobsoni* was 71 to 85 mm.

Disposal of catch

There are two main prawn traders, for procuring prawns and onward transmission to processing plants

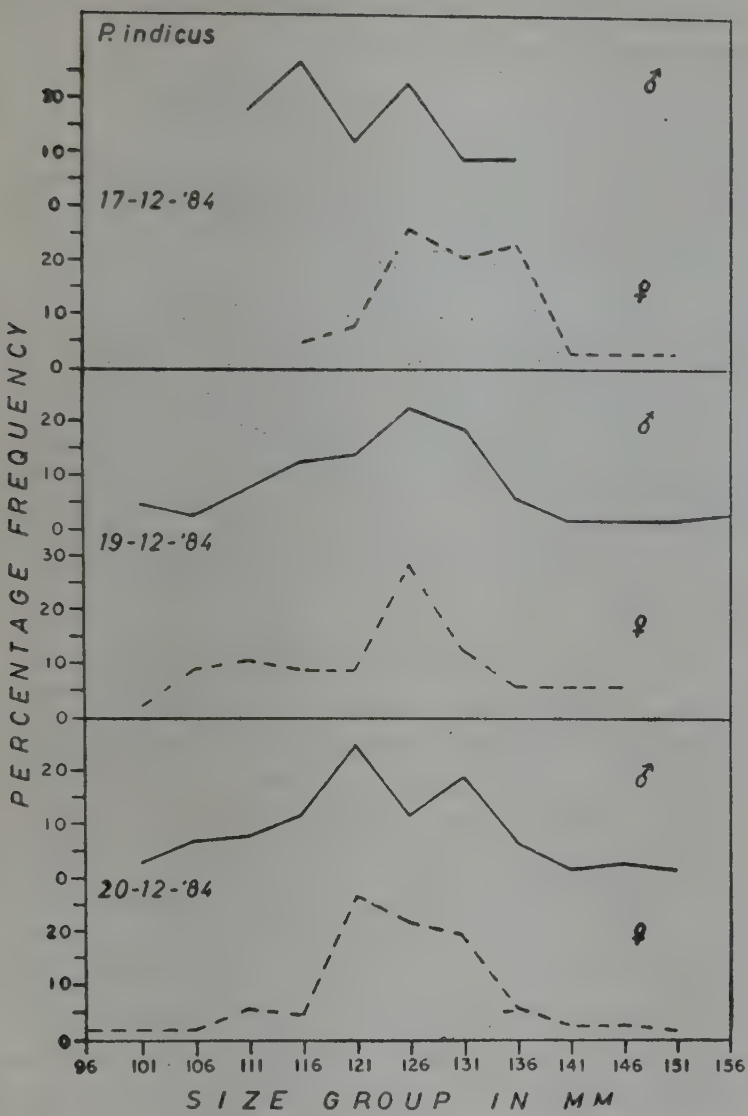


Fig. 2. Size distribution of male and female of *P. indicus* in the random samples analysed.

located in Madras city, one at Kovalam village itself and the other at Chemenjeri, situated 1 km south of Kovalam. Both were engaged in prawn business for more than two decades and so far they have not witnessed such spurt in white prawn landings from this region. First day, they offered Rs. 55/- per kg of beheaded prawns and the count per kg was 90. As these agents started sending large quantities of prawns everyday to a few particular processing plants, from whom they had drawn finance, it was beyond these factories' daily capacity of processing prawns. The companies were forced to keep excess prawns in cold storage and started processing them after 2 or 3 days; by which time, part of the stored prawns became deteriorated. Hence, they offered only Rs. 45 per kg to their respective agents stationed at Kovalam and Chemenjeri, who in turn paid Rs. 35 to 40 per kg to the fishermen. However, a marginal gain was achieved by the prawn merchants. Apart from these two local agents, prawn merchants from Madras city also purchased the white prawns at the seashore itself.

Remarks

Along the Indian coast, schooling and migration of *P. indicus* supporting a seasonal lucrative fishery have been reported at Kanyakumari district (George and Mohamed 1967; Suseelan 1973; Anon. 1975) and at Manappad-Tinnaveli coast (Mannisseri and Manimaran 1981). Recent mark–recapture experiments on *P. indicus* have also established the fact that a longer migration of tagged white prawns took place from Cochin, (place of release) to Ovari - Manappad fishing villages on the southeast coast (Tinnaveli coast), covering a distance of 330–380 km in 68 to 103 days at a rate of 3.5 to 5.5 km/day (Anon., 1982). These observations indicated a southerly migration of white prawn along the Kerala, Kanyakumari and Tinnaveli coasts. The present observation also indicated a similar southerly movement of large schools of white prawns, as evidenced by the heavy fishing along the Madras coast during 11-15th December, followed by intensive fishing at Kovalam bay during 16th–20th December.

While studying the white prawn fishery along the Kanyakumari district, Suseelan (1973) observed a southward migration of shoals from Colachel to Manakkudy, covering a distance of 32 km in 3–4 days. The southward migration of white prawns during the present study was in conjunction with the prevailing southerly current along the coast. According to Ganapati and Murthy (1954), the southerly current intensified during the northeast monsoon, particularly in December along the Madras coast, to about 2½ knots hr within 14 miles from the coast, beyond which it lowered to 1 knot. The size group which contributed to this unusual fishery was 121–130 mm, aging approximately 4–5 months, a probable brood from the second peak spawning (July–September), as mentioned for *P. indicus* in the Madras region (Anon., 1975).

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HEAVY LANDING OF *PARAPENAEOPSIS STYLIFERA* (M. Edw.) AT BOMBAY DURING POST-MONSOON 1984*

New Ferry Wharf is a major fish landing centre in Greater Bombay where fishing activity generally resumes in September after a period of lull during the southwest monsoon. This centre accounted for an annual (July–June) average of 7,530 tonnes of penaeid prawns of which *Parapenaeopsis stylifera* constituted 59.6%. The peak period of fishery for this species was observed to occur during September–December. The monthwise catch in tonnes and CPUE in kg in parenthesis (fishing trip is unit effort) during this period of different years are given below.

Year	Sept.	Oct.	Nov.	Dec.	Total
1979	188.6	388.7	317.6	821.4	1716.3
	(91.7)	(186.2)	(162.6)	(352.8)	(202.2)
1980	189.8	703.3	1166.2	967.5	3026.8
	(92.7)	(292.8)	(507.5)	(377.6)	(325.1)
1981	324.9	439.3	531.6	168.3	1464.1
	(209.7)	(191.5)	(245.1)	(73.2)	(176.1)
1982	1246.2	515.8	206.6	305.9	2274.5
	(501.9)	(180.7)	(115.3)	(107.5)	(228.0)
1983	530.1	1881.1	409.6	421.7	3242.5
	(276.0)	(415.2)	(128.8)	(174.8)	(296.2)
1984	2548.9	1386.0	—	—	—
	(842.6)	(382.1)			

It could be seen that the peak of the fishery occurred in November or December during 1979–82 whereas in the subsequent years it was in September or October. During September, 1984, exceptionally heavy landings were recorded. The area of operations was off Bombay-Janjra–Murud (about 80 km coastline) in depths of 20 to 25 m. The size (total length) of *P. stylifera* ranged from 58 to 103 mm for males and from 63 to 118 mm for females with the modal size at 83 mm and 103 mm for the respective sexes. About 10% of females was found to be in mature condition. The male-female ratio was worked out to be 1:1.68. There was no significant departure in the biological features of the fishery from those of the earlier years.

The price of the species per tonne at the landing centre ranged from Rs. 4 to 6 thousand. During the glut period, there was heavy demand for ice at the landing site and as a result the price of ice per tonne shot up from Rs. 200 to 500. The catches were transported to Porbandar and Veraval factories in Gujarat since the supply was too large to be handled by the local processors.

It is of interest to note that during September, 1984 the best landings were observed from 14th to 28th when the catch per unit varied from one to 1.5 tonnes. Simultaneously at Sassoon Dock, another major base for trawlers in Greater Bombay, the catch per unit varied from one to three tonnes. The 'dol' (fixed bag net) netters of the Alibag zone (Raigad District) stretched about 50 km south of Bombay were also reported to have netted *P. stylifera* in abundance (1.5 to 1.8 tonnes per unit of two hauls) during 23rd to 28th September, 1984. The catch that was landed in that zone was transported to Ratnagiri/Goa, the price of raw material being of the range of Rs. 1.5 to 2 per kg. Further south, in the Mangalore area (Karnataka), heavy landings of *P. stylifera* were reported more or less synchronising with this period. (Personal communications from K. B. Waghmare, J. P. Karbhari and K. K. Sukumaran). The incidence of such huge catch all along the coast at about the same time was probably triggered by some oceanographic factors such as large scale upwelling of oxygen minimum layer which might have pushed the stock towards the shore. (Vide Ramamirtham, Fishery Oceanography, *CMFRI*; *20th Anniversary Souvenir*, 1967). Unfortunately no data are available on these aspects to confirm.

Thanks are due to the Fishery Resources Assessment Division of CMFRI for making the catch data available.

*Prepared by S. Ramamurthy and A. Y. Mestry, Bombay Research Centre of CMFRI, Bombay.

THE INDIAN WHITE PRAWN *PENAEUS INDICUS* IN THE PURSE SEINE CATCHES*

The sporadic occurrence of prawns consisting exclusively of *Metapenaeus dobsoni* ('Poovalan chemmeen') in the purse seine catch at Cochin mainly during pre-monsoon season has been reported earlier by Nair *et al.*, 1982 *(Mar. Fish. Infor. Serv. T & E Ser.*, **42**: 9-13). On 23-5-'84, while monitoring the purse seine catch at the Fisheries Harbour at Cochin a purse seine landed 1.2 tonnes of the Indian white prawn *Penaeus indicus* ('Naran chemmeen') which was auctioned for Rs. 70,000/-. Since the capture of the species in such huge quantities in purse seines is quite unprecedented and has not been reported earlier, the results of the observations are given in the present communication.

On 23-5-'84, a white prawn shoal was sighted by purse seine fishermen about 20 km SW of Cochin at about 30-35 m depth, while steaming to the purse seine fishing grounds. They immediately shot the net and got the bumper catch. The catch was composed mainly of fairly large sized prawns numbering 25-30/kg of females and 30-40/kg of males (head on). The size ranged from 145 to 185 mm with the dominant modes at 151-155 and 166-170 mm for females and 135 to 170 mm with the dominant mode at 150-155 mm for males (Fig. 1). In the purse seine catch the sexes were of almost equal distribution; the females constituting 50.4% of the population. The females consisted almost exclusively of specimens with late maturing and mature gonads.

The occurrence of fairly large sized *P. indicus* in abundance in the inshore waters during pre-monsoon and monsoon periods along the southwest coast is now well known. In the indigenous fishery of Cochin, which occurs towards the beginning of southwest monsoon period more or less similar size groups of the species contribute about 35% forming the second dominant item of prawn landed by boat seines and bottom-set gill nets (George *et al.*, 1980, *Mar. Fish. Infor. Serv., T & E Ser.*, **18**: 1-8). This spices, in slightly smaller size-range, is also known to support the characteristic mud bank fishery of Ambalapuzha-Thottappally region of Kerala coast in substantial quantities during monsoon period. In the trawl fishery of Sakthikulangara-Neendakara area the species occurs in peak abundance in June, and thereafter the fishery gradually declines, thereby indicating a temporary concentration of large sized prawns in the area. Further south, almost in the same period (monsoon), this species supports a lucrative seasonal fishery in the inshore waters of the coast of Kanyakumari District and it is believed that the recruitment into this fishery is taking place from the Kerala coast. This has later been confirmed by tagging experiments *(Mar. Fish. Infor. Serv., T & E Ser.*, **45**: 1-9). All these point to the fact that *P. indicus* evinces shoaling behaviour and large scale migration to the nearshore areas from the offshore waters during the monsoon period, which are the natural habitat for the larger sizes. Probably this behavioural pattern of the species is triggerred by environmental changes brought about by the upwelling phenomenon. In this context the present observation of unusual landings of fairly large sized *P. indicus* in abundance in the purse seines is especially interesting, which could have been the result of the large scale migration of the species into the columnar waters during premonsoon and monsoon.

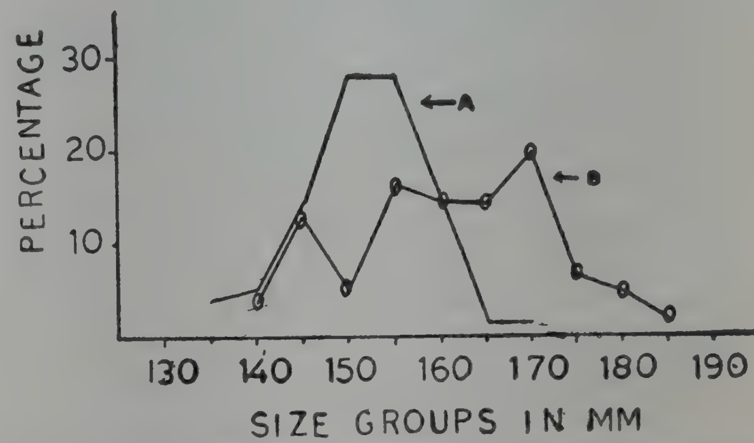

Fig. 2. Length-frequency distribution of *P. indicus* in purse seine catch at Cochin.

Fig. 1. Catch of white prawn *Penaeus indicus* landed by purse seiner at the Fisheries Harbour, in Cochin.

*Prepared by K. V. Somasekharan Nair and V. A. Narayanankutty, CMFRI, Cochin with the guidance of M. J. George and C. Suseelan.

GROWTH AND SURVIVAL OF TIGER PRAWN, *PENAEUS MONODON* IN THE SANDY BEACH PONDS AT CALICUT*

Introduction

Fast growing species of prawns which could yield short-term harvests are the most suitable species for intensive farming. At present there are about 35 species of penaeid prawns used for culture purposes in the different parts of the world. Of these, *Penaeus monodon* is one of the important species contributing to the traditional culture fisheries of the Southeast Asian countries and to the well established intensive or semi-intensive culture practices of the Indo-Pacific region. It is being cultured in Taiwan, Phillippines, Thailand, Malayasia, Indonesia, Bangladesh, India and Kuwait. In India, they are cultured in the 'Pokkali' paddy fields and perennial fields of Kerala, 'Bheries' of Sunderban area in West Bengal, salt pan reservoirs of the Godavari estuary in Andhra Pradesh and in some of the earthern ponds in the east and west coasts of India. But, nowhere culture of this species has been attempted in the polyethylene film-lined ponds made in the sandy beach. Therefore, the hardy and fast growing tiger prawn, which occurs in small quantities in Malabar area, was selected for culture experiment in a polyethylene lined sandy beach pond of the Central Marine Fisheries Research Institute between 17–7–'84 and 25–10–'84.

Material and methods

One newly lined pond with a water area of 200 m^2 and depth of 1 m was used for the experiments. Juvenile *P. monodon* with a mean size of 48.5 mm collected from Thiruvangoor and Perumthuruthi area of the Korapuzha estuary using a mosquito dragnet were used for the experiment. After the collection, the prawns were transported to the fish farm where they were conditioned overnight in plasticraft pools. The next day morning, the active young ones were selected, counted and stocked at a density of 5,000/ha. The stocking density could not be increased further due to nonavailability of juvenile *P. monodon* in the area. On 2–8–'84, ie., 16 days after stocking 200 numbers of *Mugil cephalus* collected from the same grounds with a mean size of 25.8 mm were stocked in the same pond at the rate of 10,000/ha after acclimatisation. The prawn was harvested after 100 days of rearing and the fish was allowed to grow further. Stocking and harvest details of the prawn are given in Table 1 and the growth of fish (upto the time of prawn harvest) is given is Table 2.

Table 1. *Stocking and harvest details of* P. monodon

Duration of the experiment (days)	:	100
Area of the pond (m^2)	:	200
Number of seed stocked	:	100
Rate of stocking (no./ha)	:	5000
Number of prawns harvested	:	83
Survival rate (%)	:	83
Quantity harvested (kg)	:	3.1
Mean size at stocking (mm)	:	48.5
Mean weight at stocking (g)	:	0.9
Mean size at harvest (mm)	:	165.6
Mean weight at harvest (g)	:	37.3
Increase in length per day (mm)	:	1.17
Increase in weight per day (g)	:	0.36

Table 2. *Growth of* Mugil cephalus *in the pond*

Date of sampling	Mean length (mm)	Mean weight (g)
† 2–8–'84	25.8	0.18
16–8–'84	69.3	4.50
31–8–'84	98.5	13.60
15–9–'84	121.4	23.50
29–9–'84	132.6	32.50
15–10–'84	145.3	39.60
25–10–'84	152.4	42.20

†Date of stocking.

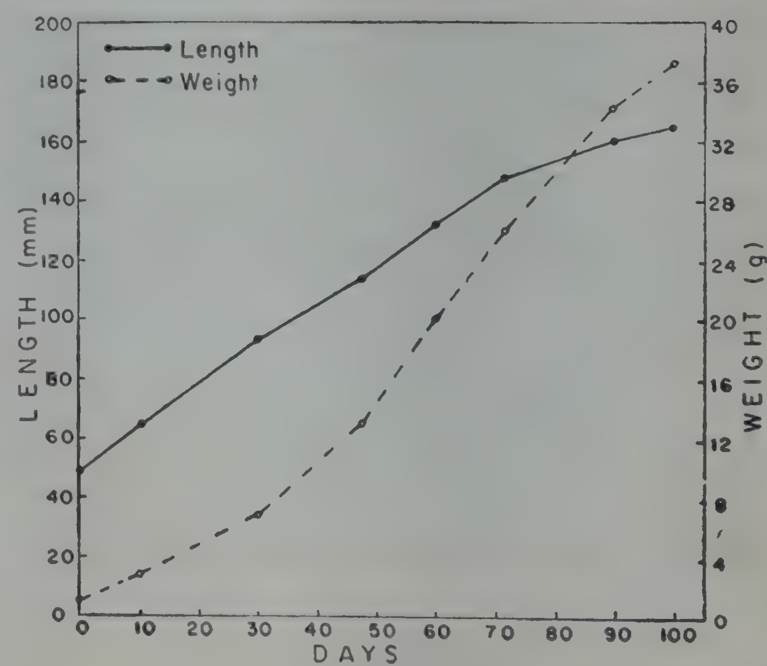

Fig. 1. Length-weight relationship of tiger prawn cultured in polyethylene film lined pond.

*Prepared by S. Lazarus and K. Nandakumaran, Calicut Research Centre of C.M.F.R.I., Calicut.

Water was pumped into the pond by using a 5 H.P. diesel pump. Periodical cleaning of the pond was done with a diesel pump by either pumping out the bottom water containing the debries or by siphoning out the water with a 3″ flexible hose after thoroughly agitating the bottom water. A compounded feed made out of groundnut oil cake, prawn head powder and tapioca waste in a dough form was given once daily by keeping it in a tray which was kept in one of the corners of the pond near the bottom. The growth of the stock was recorded once in 15 days. Temperature, salinity, dissolved oxygen content and pH of the pond water were monitored twice weekly. The salinity ranged from 12.5 to 20.7‰ and the temperature from 28.0 to 35.5°C. The dissolved oxygen content and pH fluctuated between 3.8 and 4.6 ml/1 and between 8.3 and 8.9 respectively.

Fig. 2. Growth of *Penaeus monodon* in the pond.

Results and discussion

The growth trend of *P. monodon* in the pond is shown in Fig. 1. From the figure it is seen that the length increment was comparatively faster during the first two months and a half and slowed down considerably thereafter. The weight increment seemed to be slow during the first month as well as after the completion of the third month. However, the prawn showed an overall growth increment of 1.17 mm and 0.36 g per day thus attaining an average size of 165.6 mm and 37.3 g in 100 days Fig. 2. These results are encouraging when compared to the results obtained in Taiwan where almost at similar stocking densities (5,000–8,000/ha) a growth rate of 40 g in 90 days was achieved in ponds where *Chanos chanos* and prawns were grown together (Chen, 1976. *Fishing News (Books) Ltd., London,* 162 pp.) and in Madras (Santhome) *P. monodon* in a monoculture experiment at a stocking density of 20,000/ha and stocking size of 20.0–45.0 mm (42.3 mm average) reached only 32.26 g in 80 days of growth (Sundarajan *et al.*, 1979. (*Aquaculture:* 16 (1): 73-75).

Fig. 3. *Penaeus monodon* harvested from the polyethylene lined beach pond in Calicut.

The percentage of recovery in the present study was 83.0 Fig. 3. According to Krantz and Norris *(Proc. 6th Ann. Workshop, Maricult. Soc., Seattle, Washington, U.S.A.* pp. 27-31, 1975) survival of 60–80% can be expected under suitable rearing conditions with the absence of predators, suboptimal temperatures and salinities. Further, the present data on the growth rate and percentage of recovery suggest that the culture conditions maintained in the experimental pond at Calicut were suitable for obtaining better results.

Further, it is expected that better production rate can be achieved by increasing the stocking density to an optimum level which, however, could not be carried out due to scarcity of material during the present experiment. However, the data suggest that by increasing the stocking density to $2/m^2$ as suggested by Venkatesan and Bose *(Proc. Symp. Coastal Aquaculture,* 1982, I: 146-150) and suitably altering the grow-out period, the production, rate could be increased to a greater extent.

The authors wish to express their sincere gratitude to Dr. E. G. Silas, former Director, Central Marine Fisheries Research Institute, Cochin for his constant encouragement and suggestions. They are also thankful to Shri M. Kumaran, Officer-in-charge, for going through the manuscript.

Compiled and prepared by Dr. M. J. George, Dr. K. J. Mathew, Mr. G. Nandakumar & Miss Jancy Jacob
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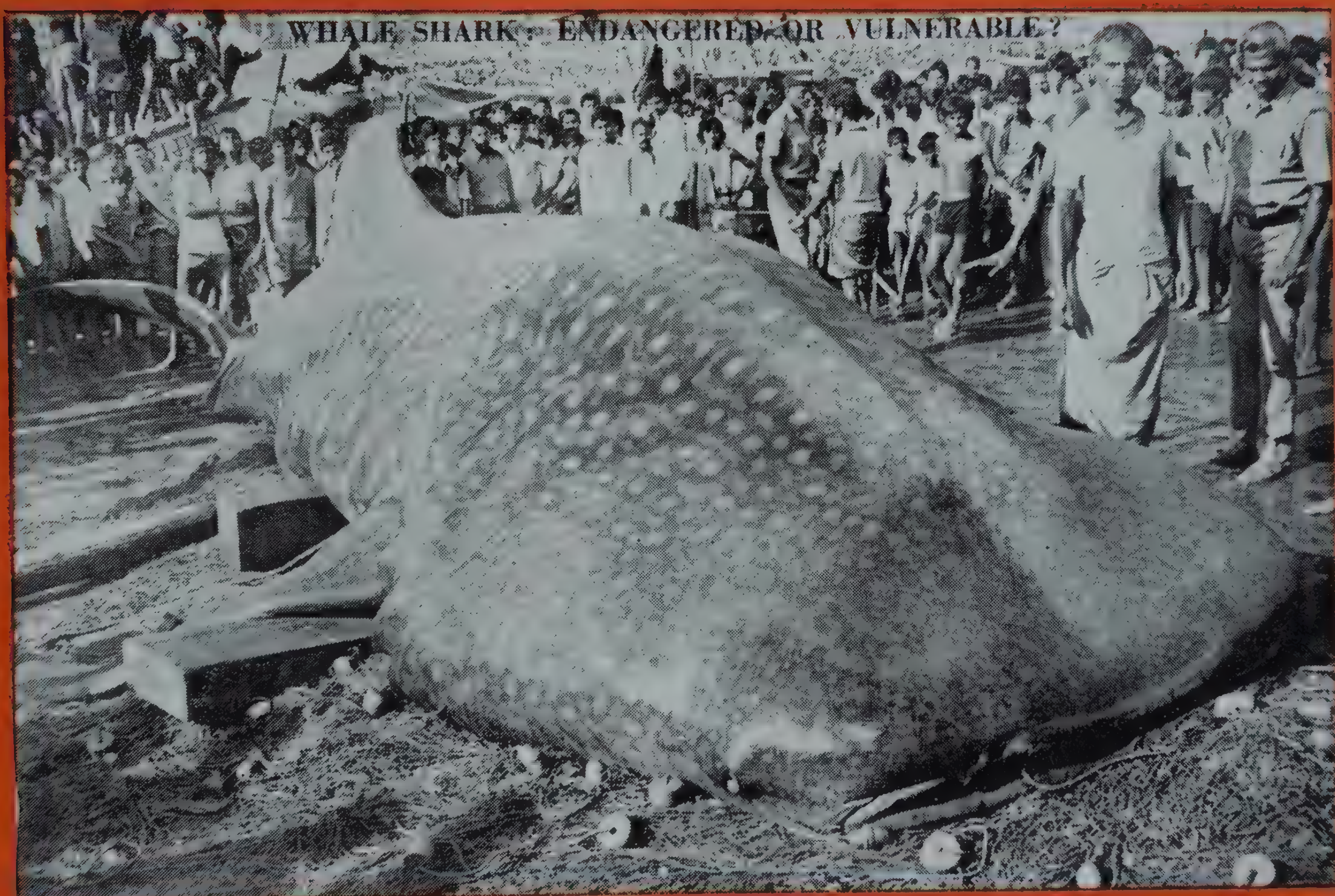

WHALE SHARK : ENDANGERED OR VULNERABLE?

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Abbreviation – *Mar. Fish. Infor. Serv. T & E Ser.*, No. 66: 1986

CONTENTS

Front cover photo: Frontal view of the whale shark showing obtuse and depressed snout and cavernous mouth.
Back cover photo: Whale shark (approx: 6 m) landed at Hejmadi, Karnataka in December, 1980.

THE WHALE SHARK (*RHINIODON TYPUS* SMITH) IN INDIAN COASTAL WATERS: IS THE SPECIES ENDANGERED OR VULNERABLE ?

E. G. Silas*

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Introduction

Notable contributions summarising our knowledge of the known habits of the whale shark in general, and its occurrence in Indian coastal waters have been made by Gudger (1935), Chevey (1936) and Prater (1941). The monumental work "The Fishes of the Western North Atlantic" by Bigelow and Schroeder (1948) lists several references to *Rhiniodon typus* Smith from various parts of the world, but there are some omissions from Indian coastal waters. Subsequent records and observations on whale sharks from Indian coastal waters and other parts of the world have added to our knowledge of this leviathan of the open seas. In the light of these, a re-appraisal seems necessary. Herein, are also added a number of records of the whale shark from Indian coastal waters, while attention is drawn to the gaps in our knowledge of the natural history of this shark so that those interested could make constructive observations as and when opportunities arise.

Silas and Rajagopalan (1963) reviewed the position regarding captures of whale shark in Indian waters until about that time, and the following authors have recorded additional captures: Gopalan (1962), Thomas and Kartha (1964), Pai and Pillai (1970), Seshappa *et al.* (1972), Pillai (1972), Freda and Bose (1973), Kuthalingam *et al.* (1973), Kunjipalu and Mathai (1976), Anon. (1981), Nammalwar and Krishna Pillai (1983), Pai *et al.* (1983) and Dhulkhed (1983).

More records of whale sharks from Indian coastal waters

1. During the first week of July, 1960, a whale shark of sizeable proportions was caught in fishing net, a few miles to the east of Tondi in the Palk Bay. The fish was towed to Thangachimadam on Rameswaram Island where it was cut up and readily sold to be cured and later exported to Sri Lanka, as its flesh is not favoured much locally. Information about the capture was received too late and hence no photographs or measurements are available except the following data. The fish weighed, excluding a part of the cartilaginous skeletal parts and the viscera, about 84 maunds (3,123.7 kg), the weight of the liver alone being 2½ maunds (93.0 kg). The flesh was sold at Rs. 12/- per maund. Besides this information it was possible to collect a few vertebrae of this fish; 14 of which in the dried condition measured 82.5 cm, the average length of each vertebra being 65 mm and the average diameter 84 mm. The vertebral centra are asterospondylous, the outer cartilaginous layer being traversed by four characteristic, outwardly radiating hardened (calcified) areas, the lateral areas being slightly wider than the dorsal and ventral ones as noted by White (1930). Between these four, but extending only very slightly from the cone are four irregular calcified ridges (intercalated calcifications) which are poorly developed in these vertebrae, probably on account of the smaller size of the animal. The centra also show a number of concentric rings of white fibrous tissue, progressively narrower towards the periphery of the centra and whether these rings could help in age determination is not known. There was hardly any way of knowing the exact length of the shark except hearsay which placed it round about six metres.

Although a rarity, the fishermen are familiar with the whale shark which in Tamil is locally known as 'Panai meen'. They recognise it as one of the sharks and their characterisation of it as of large size combined with the broad head, large transverse slit-like terminal mouth, and the slaty grey colour of the dorsal side with numerous large circular white markings and the structure of the vertebrae recovered are but definite clues to its correct identity.

2. Mr. K. Virabhadra Rao, formerly of the CMFRI, kindly informed me of the capture of a 25′4″(7.72 metres) whale shark on 16th May, 1958 at Irumeni on the Palk Bay coast, a few miles from the Central Marine Fisheries Regional Research Centre, Mandapam Camp. Reports of this capture appeared in the newspapers at that time.

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Additional details for the shark are as follows: girth of fish : 13′ 6″ (4.11 m); sex : female; weight : about 5.5 tonnes.

3. I am also informed by my colleague, Mr. S. Mahadevan about another landing of a whale shark, 28′ (8.5 metres) long, at Periathalai, near Idinthakarai in the Gulf of Mannar on 26th March, 1958. It was four days before the authorities could visit the spot and by that time the animal had become badly decomposed, but parts of the skeleton appeared to have been saved.

The fishermen call the whale shark 'Uravi' (Tamil) at Tuticorin and Idinthakarai, while further south at Cape Comorin it is known as 'Pullian surrow' (Tamil), while the name 'Panai meen' by which it is known at Palk Bay is applied by the Cape fishermen to the baleen whale.

4. On 10th December, 1960 while visiting Pozhikara, a fishing village between Cape Comorin and Colachel on the west coast, I was informed by Mr. A. C. Roche, a local inhabitant, of the capture of a whale shark in a drift net off Pozhikara during the first week of January, 1960. The fishermen who made the catch were there at the time and they had no difficulty in identifying their fish with that of a drawing of *Rhiniodon*, from amongst several drawings of cetaceans, sharks and other fishes. The whale shark was said to measure 18 feet (5.48 metres) and the liver of the animal was sold for Rs. 20/-. Since the meat was whitish and very soft, it was considered unpalatable and the carcass was towed back and dumped far into the sea.

5. To these may be added a fifth record of a whale shark caught at Vizhinjam, nine miles south of Trivandrum in February, 1960, measuring 32 feet (9.75 metres). This last record I have been able to gather from the monthly progress report of the Fishery Resources Assessment Division of the Central Marine Fisheries Research Institute.

6. A 6.1 m whale shark caught in gill net at Visakhapatnam on 25th May, 1965 and reports with a photograph of the shark appeared in the *Indian Express* dated 26th May, 1965 from Visakhapatnam.

7. A 7.67 m whale shark weighing about eight tonnes caught in 'Pattuvalai' (drift net) about 25 km off Sakthikulangara, north of Quilon on 22nd April, 1975. The depth where the net was operated was 19 fathoms as informed by Shri S. B. Chandrangathan of Central Marine Fisheries Research Institute to the author.

8. A female whale shark measuring 6.88 m and weighing about 1.5 tonnes landed at Cuffe Parade, Bombay on 18th January, 1978 and reported by Pai *et al.* (1983).

9. A female whale shark measuring 7.58 m landed at Cuffe Parade, Bombay on 8–1–1980 and reported by Karbhari (1986) in this publication (p. 20).

10. A 6.4 m whale shark landed in purse seine catch at Hejmadi on 8th November, 1980 and reported by Satyanarayana Rao (1986) in this publication (p. 22). Details are not available.

11. Another whale shark landed at Hejmadi in December, 1980 and reported here. No details are available.

12. A 7.92 m female whale shark weighing about four tonnes, caught in purse seine and landed at Malpe, Karnataka on 27th December, 1980 and reported by Satyanarayana Rao (1986) in this publication (p. 22).

13. A 5.18 m male whale shark weighing about 1.7 tonnes caught in purse seine off Malpe on 31st December, 1980 and reported by Satyanarayana Rao (1986) in this publication (p. 22).

14-16. Three male whale sharks caught in purse seine on 8–11–1980 along South Kanara coast off Yermal, Mooloor and Kaup measuring 6.71m, 4.88m and 5.65m respectively. This was directed fishing on sighting. Details are reported by Satyanarayana Rao (1986) in this publication (p. 22).

17. A juvenile female whale shark measuring 5.7 m and weighing about 2.2 tonnes caught in gill net off Anjuna, Goa on 29th January, 1981 and reported by Doiphode (1986) in this publication (p. 29).

18 – 40. 22 whale sharks taken in directed fishing from mechanised boats off Veraval. The sharks were caught by harpooning and brought alive to the harbour, and after removal of the liver the carcasses were towed back and discarded in the sea. Reported by Sudhakara Rao (1986) in this publication (p. 30).

The captures were as follows:

Dates	No. of sharks caught
12–4–1982	9
13-4-1982	7
14-4-1982	4
15–4–1982	2

Table 1. *Occurrence of whale sharks in the coastal waters of India, Pakistan and Sri Lanka*

Locality	Date	No.	Sex	Length in metres	Recorded by
(1)	(2)	(3)	(4)	(5)	(6)
A. COAST OF PAKISTAN					
1. Karachi	?	1	?	?	Buist (1850)
2. Karachi	April, 1932	1	?	?	Prater, S. H. (1941)
3. Karachi	27th March, 1937	1	?	5.48	,, (1941)
4. Karachi	April, 1937	1	?	?	,, (1941)
5. Baba Is. (s), off Karachi coast	November, 1949	1	?	11.58	Hussain, I. (1949)
B. WEST COAST OF INDIA AND GULF OF MANNAR					
1–2. Gulf of Mannar, Tamil Nadu	?	2	?	?	Steuart, J. (1862)
3. Trivandrum, Kerala	1900	1	?	8.83	Pillay, S. N. (1929)
4. Trivandrum, Kerala	February, 1909	1	?	4.14	Pillay, S. N. (1929)
5. Bombay, Maharashtra	13th February, 1938	1	M	6.55	Prater, S. H. (1941)
6. Bombay, Maharashtra	16th January, 1940	1	M	5.66	Prater, S. H. (1941)
7. Jaigarh, north of Ratnagiri, Maharashtra	3rd October, 1936	1	?	6.09±	Prater, S. H. (1941)
8. Trivandrum, Kerala	March, 1934	1	?	3.96	Prater, S. H. (1941)
9. Navapur, 104 km north of Bombay, Maharashtra	21st February, 1948	1	F	6.98	Kulkarni, C. V. (1948)
10. Madapally, 40 km north of Calicut, Kerala	12th February, 1954	1	M	6.47	Chacko, P. I. & M. J. Mathew (1954)
11. Thollayiram Parr, off Tuticorin, Tamil Nadu	11th December, 1953	1	?	6.62±	Chacko, P. I. & M. J. Mathew (1954)
12. Suratkal, 16 km north of Mangalore, Karnataka	5th March, 1959	1	F	12.09	Kaikini, A. S., *et al.* (1959)
13. Periathalai, near Idinthakarai, Tamil Nadu	25th March, 1958	1	?	8.53	Silas, E. G. (1986) (in this paper)
14. Pozhikara, north of Cape Comorin, Tamil Nadu	January, 1960	1	?	5.48	Silas, E. G. (1986) (in this paper)
15. Vizhinjam, Kerala	February, 1960	1	?	9.75	Silas, E. G. (1986) (in this paper)
16. 7 km off Veraval, Gujarat	15th March, 1961	1	F	5.25	Gopalan, U. K. (1962)
17. Okha, Gujarat	?	1	?	?	Gopalan, U. K. (1962)
18. Off Cannanore, landed at Thayyil, Kerala	27th February, 1963	1	?	4.65	Thomas, M. M. & K. Kartha (1964)
19. Calicut, Kerala	5th January, 1970	1	M	5.6	Seshappa, G. *et al.* (1972)
20. Tuticorin, Tamil Nadu	28th July, 1961	1	F	5.62	Silas, E. G. & M. S. Rajagopalan (1963)
21. Tuticorin, Tamil Nadu	26th July, 1968	1	M	5.96	Pai, M. V. & M. Pillai (1970)
22. Hare Is., Tuticorin, Tamil Nadu	16th June, 1970	1	M	7.45	Pillai, M. (1972)
23. Manapad, Tamil Nadu	2nd February, 1973	1	M	5.4	Freda & Bose (1973)
24. Pamban, Tamil Nadu	15th April, 1967	1	M	5.52	Kuthalingam, M. D. K. *et al.* (1973)

1	2	3	4	5	6
25. Kesavanputhanthurai, Colachal, Tamil Nadu	20th December, 1971	1	M	5.17	Kuthalingam, M. D. K. *et al.* (1973)
26. Vizhinjam, Kerala	23rd December, 1971	1	F	3.93	Kuthalingam, M. D. K. *et al.* (1973)
27. Vizhinjam, Kerala	16th March, 1972	1	F	5.65	Kuthalingam, M. D. K. *et al.* (1973)
28. Veraval, Gujarat	17th January, 1976	1	F	6.65	Kunjipalu & Mathai (1976)
29. Anjadiv Is., Karwar, Karnataka	21st January, 1981	1	F	8.81	Pai M. V. *et al.* (1983)
30. Karwar, Karnataka	18th March, 1983	1	?	5.35	Dhulkhed, M. H. (1983)
31. Appa Is., Kilakarai, Tamil Nadu	7th February, 1983	1	?	4.00	Nammalwar, P. & S. Krishna Pillai (1983)
32. Kilakarai, Tamil Nadu	23rd February, 1983	1	M	4.75	Nammalwar, P. & S. Krishna Pillai (1983)
33. Sakthikulangara, Quilon, Kerala	22nd April, 1975	1	?	7.67	Silas, E. G. (1986) (in this paper)
34. Cuffe Parade, Bombay, Maharashtra	18th January, 1978	1	F	6.88	Pai, M. V. *et al.* (1983)
35. Cuffe Parade, Bombay, Maharashtra	8th January, 1980	1	F	7.58	Karbhari, J. P. (1986)*
36. Hejmadi, South Karnataka	8th November, 1980	1	?	6.40	Satyanarayana Rao, K. (1986)*
37. Hejmadi, South Karnataka	December, 1980	1	?	?	Silas E. G., (1986) (in this paper)
38. Malpe, South Karnataka	27th December, 1980	1	F	7.92	Satyanarayana Rao, K. (1986)*
39. Malpe, South Karnataka	31st December, 1980	1	M	5.18	Satyanarayana Rao, K. (1986)*
40. Yermal, South Karnataka	8th November, 1980	1	M	6.71	Satyanarayana Rao, K. (1986)*
41. Mooloor, South Karnataka	8th November, 1980	1	M	4.88	Satyanarayana Rao, K. (1986)*
42. Kaup, South Karnataka	8th November, 1980	1	M	5.65	Satyanarayana Rao, K. (1986)*
43. Anjuna, Goa	29th January, 1981	1	F	5.70	Doiphode, P. V. (1986)*
44–52. Veraval, Gujarat	12th April, 1982	9	?	?	Sudhakara Rao, G. (1986)*
53–59. Veraval, Gujarat	13th April, 1982	7	?	?	Sudhakara Rao, G. (1986)*
60–63. Veraval, Gujarat	14th April, 1982	4	?	?	Sudhakara Rao, G. (1986)*
64–65. Veraval, Gujarat	15th April, 1982	2	?	?	Sudhakara Rao, G. (1986)*
66. Cuffe Parade, Bombay, Maharashtra	21st November, 1985	1	M	12.18	Karbhari, J. P. & C. J. Josekutty (1986)*
67. Cochin, Kerala	17th December, 1984	1	F	?	Somasekharan Nair *et al.* (1986)*
68. Cuffe Parade, Bombay Maharashtra	10th November, 1985	1	?	5.00	Shriram, M. (1986)*

1	2	3	4	5	6
C. East Coast of India					
1. Mouth of Hooghly, R., West Bengal	23rd March, 1908	1	?	4.26	Lloyd, R. E. (1908)
2. Madras, Tamil Nadu	February, 1889	1	?	6.70	Thruston, E. (1890)
3. Madras, Tamil Nadu	?	1	?	?	Foley, W. (1835)
4. Irumeni, Palk Bay, Tamil Nadu	16th May, 1958	1	F	7.72	Silas, E. G. (1986) (in this paper)
5. Thangachimadam, Rameswaram Is., Palk Bay, Tamil Nadu	July, 1960	1	?	6.00±	Silas, E. G. (1986) (in this paper)
6. Visakhapatnam, Andhra Pradesh	26th May, 1965	1	?	6.10	Silas, E. G. (1986) (in this paper)
7. Mullikuppam, Madras, Tamil Nadu	23rd March, 1980	1	M	7.40	James, D. B. *et al.* (1986)*
8. Royapuram, Madras, Tamil Nadu	2nd July, 1984	1	F	5.63	James, D. B. *et al.* (1986)*
9. Keelakarai, G. of Mannar, Tamil Nadu	7th February, 1983	1	?	3.15	Nammalwar, P. (1986)*
10. Solathandavankuppam, Pondicherry	30th January, 1984	1	M	4.97	Chidambaram, L. (1986)*
11. Adirampatnam, Tamil Nadu	19th October, 1985	1	?	–	Ganapathy, A. (1986)*
D. West Coast of Sri Lanka					
1. Dutch Bay	18th March, 1910	1	F	?	Southwell, T. (1912–'13)
2. Morutuva	11th January, 1883	1	?	7.24	Haly, A. (1883)
3. Negombo	January, 1884	1	?	5.48	Haly, A. (1890)
4. Colombo	February, 1889	1	?	4.39	Thruston, E. (1890)
5. Off Sri Lanka	?	1	?	?	Tennant, E. (1861)
6. Kalutara	15th January, 1942	1	M	7.62	Deraniyagala, P.E.P. (1944)
7. Beruvala	December, 1930	1	?	4.50±	Deraniyagala, P.E.P. (1944)
8. Colombo	23rd September, 1953	1	?	9.75	Deraniyagala, P.E.P. (1955)
9. Off Ralagala, Gintota	20th February, 1959	1	?	12.2±	Jonklass, R. (1959)
E. East Coast of Sri Lanka					
1. Kuchchavalli, E. Province	8th October, 1952	1	?	5.48	Deraniyagala, P.E.P. (1953)
2. Trincomalee	22nd October, 1954	1	?	4.11	Deraniyagala, P.E.P. (1955)
3–5. Nilaveli, E. Province	September, 1957	3	?	?	Deraniyagala, P.E.P. (1958)
6. Nilaveli, E. Province	10th October, 1957	1	?	6.09	Deraniyagala, P.E.P. (1958)

*In this publication

Sudhakara Rao (1986) reports that enquiries with fishermen elicited the information that about 40 whale sharks were caught during that season off Veraval.

41. A juvenile whale shark measuring 3.15 m and weighing about 1.5 tonnes. Reported by Nammalwar (1986) in this publication (P. 30).

42. An adult male whale shark measuring 12.18 m landed at Cuffe Parade, Bombay on 21–11–1983 and reported by Karbhari and Josekutty (1986) in this publication (P. 31). This is the largest authentic recorded measurement from Indian seas.

43. A male whale shark measuring 4.97 m landed at Solathandavankuppam, Pondicherry on 30th January, 1984 and reported by Chidambaram (1986) in this publication (P. 36).

44–45. Two whale sharks, a male measuring 7.40 m landed at Mullikuppam, Madras on 23–3–1980 and a female measuring 5.63 m landed at Royapuram on 2nd July, 1984 and reported by James *et al.* (1986) in this publication (P. 21).

46. A female whale shark of 3.6 m length caught off Cochin on 17th December, 1984 weighing about 1.5 tonnes and reported by Somasekharan Nair *et al.* (1986) in this publication (P. 36).

47. A 9 m whale shark landed at Adirampatnam, Tamil Nadu on 19th October, 1985 reported by Ganapathy (1986) in this publication (P. 37).

48. A whale shark measuring 5 m landed at Cuffe Parade, Bombay on 10th November, 1985 and reported by Shriram (1986) in this publication (P. 37).

Known occurrence of the whale shark in Indian coastal waters

In Table 1, the known information on capture and sighting of whale sharks in the Indian coastal waters is given along with similar data for Pakistan and Sri Lankan waters. In the latter cases, there may be some incompleteness in data, but the existing information may be indicative of the time of occurrence of the species in the coastal waters adjacent to ours. There are two additional records of whale sharks rammed by steamers over deep waters off Sri Lanka but not included in the Table. The last two records are: (1) One specimen rammed by the Dutch ship *Johan van Oldenbarnvelt* on 23rd November, 1932 about 150 miles west of Colombo and reported by Gudger (1940), the estimated length of the shark being 7.62 metres, and (2) One specimen rammed by the Japanese ship *S.S. Katori Maru* on 10th July, 1933 about 300 miles off Colombo and reported by Deraniyagala (1936), the estimated length of the shark being about 12.19 metres.

Season of occurrence

The months of occurrence of 91 captures out of a total of 98 reported herein is known (Table 2). Of these, four are from Pakistan, 63 from the west coast of India and the Gulf of Mannar, 10 from the east coast of India and eight and six respectively from the west and east coasts of Sri Lanka.

Table 2. *The month-wise occurrence of whale sharks reported so far*

Month	Pakistan	West coast India & Gulf of Mannar	East coast India	West coast Sri Lanka	East coast Sri Lanka	Total
Jan.	—	8	1	3	—	12
Feb.	—	9	2	2	—	13
March	1	6	2	1	—	10
April	2	24	—	—	—	26
May	—	—	2	—	—	2
June	—	1	—	—	—	1
July	—	2	2	—	—	4
Aug.	—	—	—	—	—	—
Sep.	—	—	—	1	3	4
Oct.	—	1	1	—	3	5
Nov.	1	2	—	—	—	3
Dec.	—	10	—	1	—	11
	4	63	10	8	6	91

It will be seen that more than 78% of the captures were during the period December–April. The largest aggregation seen was off Gujarat coast where during April, 1982 the fishermen are reported to have harpooned about 40 sharks, of which 22 were taken to the Veraval fisheries harbour for removing the liver in four days from 12 to 15 April, 1982.

On the whole the occurrences reported as captures are much more along the west coast of India, the Gulf of Mannar and the west coast of Sri Lanka (71) than along the east coasts of Sri Lanka and India (16).

Along the west coast of India and the Gulf of Mannar there are no records during May,

August and September, while along the east coast of India, the same is true for six months (April, June, August, September, November and December). These gaps may be partly due to insufficient documentation and captures going unreported. A more effective data acquisition system will be necessary. The National Marine Living Resources Data Centre (NMLRDC) at the Central Marine Fisheries Research Institute should help in such monitoring.

At this stage it is not very clear whether there is a seasonal migration of the whale shark along the coastal waters of the west coast from the south northwards. Nor is it very clear as to whether their incursions from the offshore to coastal water take place at different latitudes at different times. An annual synoptic picture of their occurrence on more sighting or captures is needed to answer some of these questions.

December to April also coincides with the season for pelagic fisheries such as sardines and anchovies along the west coast. The relationship between occurrence and forage abundance is yet another aspect which needs further study.

So also there is need to understand whether environmental parameters such as temperature and salinity play a role in their aggregation. The three records along the west coast – G. of Mannar region of India during June and July are from the Gulf of Mannar. It is not known whether the whale shark generally avoids lower salinities. Whether the absence of records from the coastal waters during May, June, July, August and September along the west coast of India which coincides with the southwest monsoon is not clear.

The records are suggestive that the whale shark is not resident in the coastal waters, but influxes come in from the offshore and high seas influenced by some extraneous factors.

Sex ratio

One of the most frustrating experiences while looking at past records is that often when workers have taken great pains to measure captured whale sharks, the sex is not reported. The known information on this from the west and east coasts of India are given in Table 3.

It will be seen that there is great insufficiency of information, the available data being only for 31 specimens from west and east coasts of India, of which 27 are from the west coast.

Table 3. *Sex composition of whale sharks reported so far*

Month	West coast of India and Gulf of Mannar		East coast of India		Total	
	Male	Female	Male	Female	Male	Female
Jan.	2	5	1	—	3	5
Feb.	4	1	—	—	4	1
March	—	3	1	—	1	3
April	1	—	—	—	1	—
May	—	—	—	1	—	1
June	1	—	—	—	1	—
July	1	1	1	—	2	1
Aug.	—	—	—	—	—	—
Sep.	—	—	—	—	—	—
Oct.	—	—	—	—	—	—
Nov.	1	—	—	—	1	—
Dec.	4	3	—	—	4	3
	14	13	3	1	17	14

With the present state of knowledge of the species, it is difficult to say whether sexual segregation occurs in the whale shark either of a "behavioural" type as noted in the case of the spiny dog fish *(Squalus acanthias)* by Ford (1921) or of a "geographical" nature as reported in the case of the soupfin shark *Galeorhinus zyopterus* (Ripley, 1946), and the white-tip shark *Pterolamiops longimaness* (Backus *et al.*, 1956). Information such as size at first maturity, maximum size attained by both sexes and reproductive potential are not available.

Mode of development

Until recently speculation was rife as to the mode of development of the whale shark, the general belief being that it was viviparous. In fact, late Dr. Gudger, the greatest authority on whale sharks, once remarked (Gudger, 1935) that "It is my judgement that the whale shark will be found to be viviparous – *i.e.* a live-bearer. The young when born must be of good size, too large to be hatched from a shelled egg extruded into the water. The just born young must be atleast three to five feet long–perhaps as much as eight to ten. *Quien sabe!*" However, the earliest indication that this giant fish could be oviparous was suggestive from Southwell's observation (1912-'13) based on a specimen taken at Dutch Bay, west coast of Sri Lanka in which he found "...very ripe ovary, oviduct full of eggs, 16 cases counted, same form as in dogfish." This observation, although very significant was discounted by Gudger (1933) who

opined that Southwell's shark could have been a *Galeocerdo tigrinum,* although Southwell (in litt. see Gudger, 1933) appears to have been quite positive about his identity of the shark. However, based on Southwell's observations, Bigelow and Schroeder (1948) suggested the possibility of the mode of development of *Rhiniodon* being ovoviviparous, and changing his views on the same grounds Gudger (1952) conceded oviparity to be a possibility.

Of exceptional interest is the discovery of an egg case containing a fully developed embryo of the whale shark from the coastal waters of the Gulf of Mexico off Texas (Baughman, 1955). The embryo when released from the egg measured 14½ inches (37 cm) in total length and was bluish grey, dorsally with the characteristic white spots, the ventral side of the body being whitish. The egg case was 12 inches long, 5½ inches wide and 3½ inches thick (35 x 14 x 9 cm) and "presented every appearance of having been in the water for some time, one side of it being worn, as if by sand." Baughman further remarks that the discoverer of the egg, Captain Freeze found a large whale shark, longer than his 65-foot shrimp trawler *Doris,* on or about 2nd July, 1953, (the day that the egg was taken), swimming on the surface in the same area a number of times. For a redescription and an additional drawing of this embryo, reference is invited to Reid (1957) and Garrick (1964). One point of interest is that the egg was trawled from 51 m in the coastal waters and in this context Southwell's find of a gravid female whale shark in the month of March in coastal waters is significant as it suggests that this shark besides undertaking migratory movements to feeding grounds could also seek sheltered coastal waters for breeding.

However, the controversy as to whether the whale shark is viviparous or oviparous or ovoviviparous still continues. The Gulf of Mexico embryo had an external yolk sac of about 6.3 m^3 and a stalk 24 cm long and Reid (1957) commented on the extent of absorption of yolk and opined that the embryo was close to hatching. Wolfson (1983) examining early juveniles of whale sharks, found in three of the specimens measuring 55.0, 62.0 and 63.0 cm "a faint indentation is all that remains to mark the stalk" a condition seen in some other elasmobranchs where the "umbilical scar" disappears a few months after hatching. Garrick (1964) postulated that the Gulf of Mexico embryo had yolk in its abdomen which was confirmed by Wolfson (1983). The presence of an umbilical scar in a 55.0 cm (TL) juvenile led Nolan and Taylor (1978) to suggest a viviparous mode of reproduction for the whale shark. In pointing out that the whale shark's mode of reproduction is still uncertain, Wolfson (1983) remarks that "The egg case of *Rhiniodon* is light amber in colour and extremely thin............the corners may have possessed 'rudimentary' tendrils, but that would have been insufficient to allow for anchoring... and that the case does not appear to be well adapted to withstand conditions on the sea floor." Wolfson (1983) further points out that the embryo could have been aborted by the shark. In the light of these it is quite evident that the mode of reproduction of the whale shark is still an open question. The evidence, therefore suggests ovoviviparity.

Size

The size of whale sharks caught or stranded have always been a matter of interest and the smallest known specimen, besides the 37 cm (given by Wolfson, 1983 as 35.5 cm) embryo mentioned earlier, are six specimens 55.0, 56.0 (2), 62.0, 63.0 and 93.0 cm in TL collected in purse seine from the high seas of Eastern Pacific and Tropical Atlantic where the depth was well over 2,600 m. The next may be the 6 feet (1.81 m) specimen from Cuban waters (Bigelow and Schroeder, 1948). The largest on record is one, a few inches over 59 feet (ab. 18 m) from the Gulf of Siam (Smith, 1925, not actually measured). I am unable to comment about the plus 65-foot specimen mentioned in Baughman's account (1955) from the Gulf of Mexico. However, the longest actually measured specimen appears to be the one recorded from the Seychelles Islands by Wright (1870) as measuring 45 feet (13.72 m). In Indian coastal waters the smallest on record is 3.15 m and the largest 12.18 m, a male.

Shri Ali Manikfan, formerly of the Central Marine Fisheries Research Institute, who hails from the Minicoy Island in the Lakshadweep Archipelago informs me that he has seen on atleast three occasions whale sharks caught at Minicoy, but none of the specimens was longer than eight feet. Their occurrence is rare, but the local fishermen are well aware of its passive and harmless disposition, and call it 'Vori mas meer'. The name 'Vori mass' is applied by them to species of *Siganus stellatus* (Forskal) which has got a blotched colour pattern, from which probably the name of the shark is also derived.

Out of the 68 records from the Indian seas, the length measurements are available for only 49 specimens and these are given in Table-4.

From the above statement it is apparent that individuals between four and nine metres are more liable to be encountered in Indian coastal waters.

Table 4. *Length measurements of whale sharks caught from Indian seas*

Sl. No.	TL (m)	No. of specimens	Sl. No.	TL (m)	No. of specimens
1.	3.0–3.9	3	6.	8.0–08.9	3
2.	4.0–4.9	7	7.	9.0–09.9	1
3.	5.0–5.9	15	8.	10.0–10.9	—
4.	6.0–6.9	11	9.	11.0–11.9	—
5.	7.0–7.9	7	10.	12.0–12.9	2

What is intriguing is that we have no information on specimens less than 3 m. The work of Wolfson (1983) points to the occurrence of small whale shark occurring in the high seas and have been taken by the purse seine operated for tuna fishing. The information I have received from Ali Manikfan from the Lakshadweep also suggests that early juvenile whale sharks may be found in oceanic waters. This information gap on early juveniles need bridging. Similarly our information on specimens 10 m and above is extremely meagre.

Food

But for stray observations which have led to two schools of thought, nothing much is known about the food of the whale shark. Gudger (1939, 1953), Prater (1941) and Deraniyagala (1944) have tried to correlate the occurrence of whale sharks in Indian coastal waters with the abundance of zooplankton in these areas. Von Kampen (1908) found shells of small *Sepia* and some small fishes (Gobiids and Saurids) in the stomach of one specimen harpooned in Batavia Bay, Indonesia and on more than one occasion the whale shark has been noticed to feed on tuna bait fish, namely anchovies and sardines (Gudger, 1915, 1918, 1935, 1941a, 1953). On the contrary, Wright (1868, 1870) found large masses of algae as stomach contents of the whale shark he examined in Seychelles and concluded that the whale shark was herbivorous. Later, Pflueger's examination of a 5.5 m whale shark harpooned off the Florida coast showed the stomach to contain nothing but seaweeds and a large quantity of partly digested and consequently unrecognisable food material (Gudger, 1932a). In Indian coastal waters, Mc Cann's (1954) examination of the stomachs of two specimens and the observations of Kaikini *et al.* (1959) show that marine algae could as well form an item of the food of the whale shark during its visits to the coastal waters. It is also possible that the dietary habits of this fish may change with age. Southwell's (1912–'13) remark that the stomach of the gravid female specimen taken at Dutch Bay, west coast of Sri Lanka, was empty, is also of interest. Although, from this it would appear that the whale shark is an omnivorous feeder and not a purely zooplankton feeder or a herbivore, the final word has not yet been said and it is desirable to have more information about the food of this, larger of all fishes.

Natural enemies and longevity

Gudger (1953) mentions intestinal parasites as the only mortal enemies of the whale shark, while ramming by ocean going vessels also accounts for a few others being killed. According to him, if *R. typus* escapes these, only "one end awaits him–Death from Old Age-from the degenerative metabolic changes and processes consequent on aging." To this should be added fishing with gill nets, purse seines and harpoons. Another limiting factor which he overlooked and which Mc Cann (1954) has rightly drawn attention to, is the possibility of younger individuals being more susceptible to dangers of mortality. In fact, now that we know that the newly hatched whale shark is less than half a metre long, it is undoubtedly subject to dangers of predation and only a very fast growth rate could help it minimise mortality rate. In addition, many of the captures of smaller individuals may take place in coastal waters and go unreported or it may not excite curiosity even if reported on account of the smallness of their size. Capture and stranding of larger individuals by themselves may be contributory factors in limiting their ultimate numbers.

Gudger's surmise of intestinal parasites of the whale shark is also based on Southwell's report on the Dutch Bay specimen in which he found "..... six huge cestodes in gut......a number of soft, round, pink cysts also found on walls of stomach. Spiral valve full of holes. Cestodes numerous, all Tetrahunchids." It is interesting that neither Mc Cann (1954) nor Kaikini *et al.* (1959) found any parasites in the stomach in spite of detailed examination of the stomach of three specimens.

Wilson (1907) has reported on some gill parasites of whale sharks. Wright's record (1877) of a new genus and species of *Pandarina* as parasitic on the whale shark should also be mentioned here. Thus it will be seen that only very scanty information is available regarding external as well as internal parasites of the whale shark.

Apparently only three instances are on record of whale shark carcass being drifted ashore, one near Madras in 1889, the second on the Florida coast in 1902 (Gudger,1952) and the third recently recorded by Deraniyagala (1955) as having been washed ashore at Colombo

on 23rd September, 1953. A few records of dead whale sharks washed ashore, but inspected after a few days or even several days after the occurrence could represent specimens caught and draged ashore by fishermen and subsequently dead. In view of the tendency of the whale shark to sink rapidly when killed in open waters (Tubb, 1948), or when rammed and killed by ocean going vessels the three instances cited above are of interest, although in neither case information is available about the cause of death, as whether due to natural causes, injury or infection.

Schooling behaviour

In the open seas as well as in some of the coastal waters of the world, the whale shark has been observed to swim about in small schools, but the reasons for such congregations are least understood, some suggesting a mode of group feeding. Thomas (1887) apparently was the first to observe a school of whale shark with individuals from 25 to 40 feet long in association with other sharks in New Guinea waters. Subsequently, Weber (1902) noted among a school of sharks and rays in the Strait of Buton, between the islands of Buton and Muna, southeast of Celebes, several whale sharks, which appeared least concerned about the expedition ship *Siboga*, but went about playing around the vessel and struck its bow. Other records of whale shark schools are given by Gudger (1935, 1939) and a recent report appears to be the one recorded by Tubb (1948), who observed two small schools of whale sharks, the smallest school consisting of nine sharks ranging in size between 20 and 35 feet (6.09 and 10.66 metres) in Darvel Bay, British North Borneo. The capture of two specimens at the same time at Madapally on the west coast of India (Chacko and Mathew, 1954) is the first indication of such schooling behaviour in our waters. However, more recently we have seen aggregations in Gujarat waters off Veraval which definitely points to their schooling in some parts of our coastal waters.

Association with tuna

Very significant is the tendency of *Rhiniodon* to associate with larger schooling fish. Gudger (1941) has given a number of instances of associations between *Rhiniodon* and the Bonito in Japan, Cuban waters, off Havana, Manzanillo, Gibara and Vita. In the Bahamas, the whale shark has been seen along with tuna schools and the same association has been noted also off Lower California. The behaviour of the whale shark when in association with bonitos and tunas suggests that they might have been together in seeking their food.

In oceanic waters, whale shark is considered as an indicator of tuna schools and regularly so along North West Africa (Wolfson, 1983). Association of whale sharks and tunas have been also reported by Tubb (1948) from North Borneo; Baughman (1955) from British Honduras; Baughman and Springer (1950) and Springer (1957) from U.S. and Mexican waters; Fourmanoir (1955, 1961) from Malagasy; Iwasaki (1970) from Japan and Cropp (1978) from Australia. The capture of early juveniles in purse seine operations over deep water reported by Wolfson (1983) is also interesting.

On the west coast of India, the period from November–December to April is the time when sardines and mackerel occur in abundance, and as already noted, this period coincides with the occurrence of whale sharks in the coastal waters of that area. This is also the period when schools of bonitos, frigate mackerels, skipjack and yellow-fin tunas visit the coastal waters along the west coast of India and it will be worth finding whether any such associations between these larger fish and the whale shark exist in our waters. In fact, off San Diego on the California coast, whenever the whale shark is sighted, fishermen know that it will be invariably surrounded by yellowfin tuna and head for it (Gudger, 1941 *a*).

Other animal associates

Composite schools of whale sharks and other sharks and rays have been reported by Thomas (1887), Weber (1902), Gudger (1941 *a*, *c*), Tubb (1948) and others. Off Sri Lanka waters, Captain James Steuart (1862) observed that "...sharks of the ordinary description are frequently seen: and on two occasions my attention has been called to spotted ones of such monstrous size as to make the common ones at their sides appear like pilot-fish."

The sucker fish or remoras are known to be associated with the whale shark (Gudger, 1935) and in the open seas have been observed to freely enter and leave the oral cavity of the shark (Gudger, 1922; Prater, 1940). Jonklass (1959) gives a fascinating account of his encounter with a 40-foot whale shark off Sri Lanka coast while aqualung diving, and recollects seeing 'pilotfish' hovering around the mouth of the shark. In fact, one such fish has even been taken from the stomach of a whale shark (Kishinouye, 1901), probably swallowed inadvertently at the time of capture. In one of the whale sharks landed at Sassoon Docks, Bombay, Prater (1940) found a sucker fish cleaving to its palate, well inside the mouth.

Tubb (1948) also mentions of an interesting association between the whale sharks and small shoals of

stromateid fish (young *Stromateus cinereus*), the latter swimming "almost invariably on their sides, suggesting pleuronectids and although somewhat scattered, each shoal closely followed the movements of its gigantic companion. The stromateids appeared to generally travel about one fathom below the whale shark." When one of the sharks was killed, the accompanying stromateid shoal transferred its allegiance to the launch and stayed beneath it until the speed was increased, suggesting the natural tendency of these smaller fishes to take shelter under or follow in the wake of giant fishes. In Indian coastal waters, only Chacko and Mathew (1954) mention of fishermen having seen such an association between *Stromateus cinereus* and the two whale sharks they reported on at Madapally.

Yet, another interesting association is that between the whale shark and enormous shoals of the carangid fish *Caranx gymnostothoides* noted regularly off Seychelles Islands (Gudger, 1932 b).

Whale sharks and underwater sound

Are whale sharks capable of producing underwater sound? Hitherto there has been nothing to indicate that they are concerned with purposeful sound production of a biological nature or even mechanical sound production. However, Mr. S. Mahadevan who was connected with the pearl fishing operations in the Gulf of Mannar during the past few years informs me that pearl divers are familiar with the 'Uravi' or whale shark which is not at all uncommon in the Pearl Banks off Tuticorin during the pearl fishing season extending from November to about April. The curious thing is that fishermen while diving recognise the presence of the shark, even when it is quarter of a mile away, by a peculiar intermittent snapping or grating noise, well audible under water. The volume of this crackling noise resembling that made by a heavy disused door moved on its rusted hinges, it appears, if heard at close quarters under water is really deafening. (It sounds very cetacean to me). Once when the divers indicated the presence of an 'Uravi' in the vicinity, Mr. Mahadevan immersed his head under water and sure enough, heard the peculiar grating sound. A few moments later a large swirl in the water a few hundred metres away indicated the place where the animal had sounded. Although the divers are well aware that the shark is harmless in spite of its enormous size, the moment they hear its noise under water they come up and remain in the boats for 5 to 10 minutes by which time the direction of movement of the shark would be known, and when it has passed by they recommense diving.

The absence of air bladder in the whale shark will rule out the sound as being accomplished by the air bladder and associated organs as is the case with many of the sciaenids, perches, etc. For such a large animal with hardly any natural enemies, the purposefulness of any biological sound production as a warning sign may be ruled out. Mechanical sound production appears to be the only possibility and under this category too, as the shark passively swims about, there is no likelihood of its producing such sound as a result of body movements directly involved in swimming. Nor is it likely that the exhalation of water through the gill openings could account for such sound. As such, I feel that the mode of feeding possibly has something to do with the sound produced by this shark. As the oral armature may give a clue, the nature of the dentition as described by Gudger (1953) is given below: "......the very small teeth are in contrast with the 4- or 5-ft wide jaws. They form in each jaw a band (of about 3,600 teeth in a 31.5 ft specimen) extending from angle to angle of the great jaws......The band is composed of rows of teeth extending from front to back. Each row has from 10 to 12 or 14 teeth pointing backwards. Each tooth has a bulbous base and the tooth proper is sharply recurved flatly to the rear (the interior of the mouth). The cusp of the tooth, that is, the part covered with enamel, is only about three-sixteenths of an inch long. It does not stand upright, as do other sharks teeth, but is bent flatly backwards and inwards..."

The quick and successive snapping of the jaws and the consequent grinding of the numerous teeth may perhaps produce the grating sound. That this is a possibility is understandable from Dr. Fish's (1954) observation on the mechanical sound produced by the smooth dogfish *Galeorhinus laevis* Valmont. She remarks that the sounds of five of these fishes "were audible only when they were swimming with fins partly out of water or occasionally when feeding on crabs......However, the noisy grinding of the numerous flat granular teeth of a 'pack of sea hounds' over favourite shoal feeding grounds may be expected to reach considerable volume." It is interesting that in the Pearl Banks off Tuticorin the fishermen should associate this characteristic underwater sound only with the whale shark and not with any other sharks, skates or rays nor with any of the reef fishes or cetaceans.

I have still reservations as to whether this could be the sound produced by the sperm whale or any other cetacean. No doubt, this reported mechanical sound production in the whale shark needs confirmation.

Synonyms: GENUS *RHINIODON* SMITH, 1928

Rhincodon Smith (1929)
Rineodon Muller and Henle (1838)
Rhiniodon Swainson (1839)
Rhinodon Muller and Henle (1841)
Micristodus Gill (1865)
Cetorhinus Poey (1876) *nec* Blainville (1816)
Selache Thomas (1887) *nec* Cuvier (1817)

The genus *Rhiniodon* Smith which is monotypic, is now placed under the family Rhincodontidae, although at one time Regan (1908) treated it as a member of the family Orectolobidae.

The generic name is spelt differently, but *Rhiniodon* being the first used, is followed here. The matter of usage of *Rhiniodon* or *Rhincodon* is under consideration of the International Commission on Zoological Nomenclature (Hubbs *et al.*, 1976; Wheeler, 1982). Until a ruling is made on this by the Commission, it will be desirable to use the original spelling *(Rhiniodon)*.

RHINIODON TYPUS SMITH

(1828, S. African Comm. Advertiser, **3** (145): 2. Type locality: Table Bay, South Africa)

In a check-list of elasmobranch fishes from Indian seas, Misra (1947) gives a very incomplete list of seven references to the whale shark from the Indian seas. To facilitate workers in this region, I have given below as far as possible a complete list of references and synonymy referable to *Rhiniodon typus* Smith from Indian coastal waters. *Micristodus punctatus* Gill (Gulf of California), *Cetorhinus maximus* Poey (Cuban waters), *Selache maxima* Thomas (New Guinea), *Rhinodon pentalineatus* Thomas (New Guinea) and *Rhinodon pentalineatus* Kishinouys (Japan), all described or named from extra Indian waters but not included in the ensuing list are synonyms of *Rhiniodon typus* Smith.

Synonymy and references

(Unusual Sea Monster) Foley, 1835. *J. Asiat. Soc. Bengal*, **4**: 62-63 (Sight record off Madras).

(Great Basking Shark or 'Mhor') Buist, 1850. *Proc. Zool. Soc. London*, **18**: 100 (Fishing off Karachi, West Pakistan).

(Basking Shark) Tennant, 1861. *Natural History of Ceylon.* (Off Ceylon, now Sri Lanka, in Gulf of Mannar).

(Spotted Monster Shark) Steuart, 1862. *Notes on Ceylon* etc. p. 156 (Sight records at Ceylon Pearl Banks).

Rhinodon typicus Haly, 1883. *Ann. Mag. Nat. Hist.*, **5** (12): 48 (Ceylon); Day, 1888. *Fish. India, Suppl.*, 811 (Ceylon); 1889. *Faun. Brit. India, Fish*, **1**: 29 (General); Thruston, 1890. *Bull. Madras Govt. Mus.*, 99-100 (Ceylon Pearl Banks); 1894. *Ibid.*, 36-38, pl. 3 (Ceylon and Madras); Lloyd, 1908. *Rec. Indian Mus.*, **2**: 306 (Mouth of Hooghly River, Bay of Bengal); Regan, 1908. *Proc. Zool. Soc. London*, **353** (Ceylon, etc); Southwell, 1912-'13. *Ceylon Adm. Rept. Mar. Biol.*, E 44, E 49 (Ceylon) (Eggs and intestinal parasites); Pillay, 1929. *J. Bombay. nat. Hist. Soc.*, **33**: 351 (Trivandrum, Kerala, India).

Rhineodon (no specific name), Gudger 1933. *Nature, London*, **131**: 165 (Ceylon).

Rhineodon typus Gill, 1905. *Science*, **21**: 790 (Indian fishery and habits); Gudger, 1931. *Bull. Amer. Mus. Nat. Hist.*, **61**: 613-637 (Mounted skins of whale sharks in world Museums including the ones at Colombo (Ceylon), Madras and Trivandrum (India); structure, habits, comparative measurements of specimens from Table Bay (S. Africa), Florida, Madras and Ceylon); Pearson, 1933. *Nature, London*, **131**: 729 (Ceylon); Gudger, 1935. *J. Amer. Mus. Nat. Hist.* (Natural History), **36** (2): 128-132 (Mounted skin of whale sharks in various museums of the world including those at Colombo and Madras); 1935. *Proc. Zool. Soc. London*, 863 (List of records upto 1934); Chevey, 1936. *Inst. Oceanogr. de L' Indochina*, **28**: 1-31 (Indochina and previous Indian records cited from literature); Gudger, 1937. *Nature, London*, **139**: 549 (whale shark rammed off Ceylon); 1938. *Copeia*, **172** (whale sharks rammed off Ceylon, Red Sea *etc*); 1940. *Sci. Monthly*, **50**: 225-233 (Habits, also mounted skins in world museums including ones at Colombo, Trivandrum, etc); 1940. *New England Naturalist*, **7**: 1-10 (Ramming of whale sharks by ocean going vessels near Colombo, Red Sea, etc); 1941. *Amer. Nat.*, **75**: 550-568 (whale sharks unagressive towards and unafraid of man, instances from all seas including Indian Ocean); Prater, 1941. *J. Bombay nat. Hist. Soc.*, **42** (2): 225-279 2 figs. and 7pl. (General, coastal waters of India and Ceylon, habits); Deraniyagala, 1944. *Ibid.*, **44** (3): 426-448, pl. 1 (Ceylon); Kulkarni, 1948. *Ibid.*, **47**: 762-763 (Navapur, N. of Bombay); Gudger, 1952. *Amer. Nat.*,

86 (827): 113-116 (Records of *Rhiniodon* carcass drifting ashore, one at Madras in 1889, etc); 1952. *Copeia*, **4**: 266–267 (whale shark possibly an egg-layer); 1953. *J. Bombay nat. Hist. Soc.*, **51**: 879-884 (Habits); McCann, 1954. *Ibid.*, **52**: 623-624 (Malabar coast and Gulf of Mannar).

Rhincodon typus Fowler, 1941. *Bull. U.S. nat. Mus.*, **100** (13): 116-117 (Description, synonyms and distribution. Indian records cited); Misra, 1947. *Rec. Indian Mus.*, **45**: 9 (Synonymy, very incomplete); Bigelow and Schroeder, 1948. *Mem. Sears Found. Mar. Res.*, **1**, *Fish. Western N. Atl.*, 187-195, fig. 30 a-f (Description, synonymy); Misra, 1952. *Rec. Indian Mus.*, **49** (1): 99, fig. 2*a*; Deraniyagala, 1952. *A coloured Atlas of some vertebrae from Ceylon*, 1, Fishes, 7 pl. 1 (General; Ceylon); 1953. *Spol. Zeylan.*, **27** (1): 43, pl. 1. (East coast of Ceylon); 1955. *Ibid.*, **27** (2): 241 (One record each from east and west coasts of Ceylon); Munro, 1955. *Marine and Freshw. Fish. Ceylon*, 3–4, pl. 2, fig. 5 (Reference); Jonklass, 1959. *Times of Ceylon*, Sunday Ed.; Deraniyagala, 1958. *Spol. Zeylan*, **28** (2) (Eastern Province of Ceylon); John, 1959. *Bull. Res. Inst. Univ. Kerala, Ser.* C, **7**: 93 (Reference, Cape Comorin Bank); Kaikini, Rao and Dhulkhed, 1959. *J. mar. biol. Ass. India*, **1** (1): 92-93 (West coast of India); Gopalan, 1962. *J. mar. biol. Ass. India*, **4** (2): 231-232; Silas and Rajagopalan, 1963. *Ibid.*, **5**: 163–67; Thomas and Kartha, 1964. *Ibid.*, **6**: 174-175; Pai and Pillai, 1970. *Ibid.*, **12** (1 & 2): 224-225; Pillai, 1972. *Ibid.*, **14** (1): 408-409; Seshappa *et al.*, 1972. *Indian J. Fish.*, **19**: 200-201; Freda and Bose, 1973. *J. mar. biol. Ass. India*, **15** (1): 438-439; Kuthalingam *et al.*, 1973. *Indian J. Fish.*, **20** (2): 647-651; Kunjipalu and Mathai, 1976. *Fish. Technology*, **8** (2): 161-162; Pai *et al.*, 1983. *Indian J. Fish.*, **30** (1): 157-160; Nammalwar and Krishnapillai, 1983. *Mar. Fish. Infor. Serv. T& E Ser.*, **49**: 24-25; Dhulkhed, 1983. *Ibid.*, **49**: 25.

For recent records reference should be made to reports in this publication which are also listed in Table 1.

Local names

West Pakistan

'Mhor'

West coast of India

'Karanj', 'Bhariat', 'Bahiri' (Marathi)

'Makara sravu', 'Osman shira' (Malayalam)

'Pulli-udoombu', 'Pullian surrow'(Tamil)

Lakshadweep Islands

'Vori mas meer'

West coast of Sri Lanka

'Muni-muthu-mora' (Singhalese)

Gulf of Mannar

'Panai meen', 'Uravi' (Tamil)

Palk Bay, east coast of India

'Panai meen' (Tamil)

Whale shark in the Jataka Sculpture of 2nd B.C.

The present discussion also necessitates clarification of any doubtful references to the whale shark, especially from this area. In this connection, two notes by the late Dr. Hora (1955, 1956) referring to the *Timingila Jataka* Medallion of the Bharhut reliefs of the 2nd century B.C. as representing a whale shark and not a whale calls for a re-study. Hora (1956) remarks that "......... its food-fishes, such as mullets, sardines and small perches, are shown in the medallion......When the fish inhales water for oxygenating its gills, the power of suction is so great that small boat with three occupants could be sucked into its cave-like mouth as is so clearly shown in the medallion. It is evident, therefore, that even sizeable fish and other animals, besides plankton and small shoaling fishes, could form the food of the whale shark." The *Timingila* is represented as a pisciform animal with the body covered with scales, with a very large head and an enormously large mouth fringed with conspicuous conical teeth, but with the lower jaw shorter. The eyes are large, and still more significant is a spout of water shown cascading from near the anterior end of the snout and seen curving backwards as well as forwards. While it is difficult to imagine that such a creature could in any way be connected with the whale shark, there is no reason why it could not be the product of an artists imagination of a whale! The enormity of the animal and the known disposition of some whales to even attack or upset a boat in the vicinity with their sudden movements could have given rise to the scene depicted in the medallion, the scales on the body shown again being a matter of imagination and

the small fishes only adding flavour to the marine environment and not forming food of the whale. Besides, a whale is known as *Timingilam* in Tamil, *Timingalam* in Malayalam and *Thimingilamu* in Telegu, while as will be seen from the local names given above, the whale shark is not known to be denoted by the name *Timingilam.*

A second doubtful identity of the whale shark from Indian waters may also be mentioned here. Burton (1940) remarks of a sight he saw two days after leaving Chetlat Is. in the Lakshadweep Archipelago for Mangalore as "………an enormous dorsal fin moved along four or five feet out of the water at a distance of several hundred yards, but what creature it belonged to we could not make out; perhaps it was a whale shark *(Rhiniodon typicus)* which usually swims near the surface with part of its dorsal fin exposed." It may be mentioned here that *R. typus* besides having a moderately large dorsal fin has also a large upper caudal fin lobe which surely should be partly seen when the fish swims, at the surface, as figured by Norman and Fraser (1937, pl. 2, fig. A). It is not unlikely that the animal sighted could be a solitary killer whale *Orcinus orca* which has a conspicuous dorsal fin and which in a 30 feet specimen may be nearly six feet high.

Centre of origin and dispersal

Gudger (1935) opined that a fish so markedly distinct and circumtropical in distribution should have had only one centre of origin and assigned the Sulu Sea in the south west part of the Philippines as the focal point from where the whale shark originated and subsequently got dispersed. The basis for this postulation was that as on December 31, 1934 for a period of 107 years, out of 76 whale sharks recorded from all seas, 17 were definite records for the general region of the Sulu Sea "with as many more being checked up." At that time he listed only 10 definite records from Indian coastal waters, which Prater (1940) raised to 20, and I have in this contribution referred to 78 + occurrences. Now, this increase in the number of records from Indian coastal waters has also kept pace with additional records from all seas which to date may add to number a few hundred. To presume that the abundance of an organism at one place in the present day and its relative scarcity in other areas should indicate the former area to be the centre of origin of a species is a highly controversial subject. For a study of the origin and present day distribution of the whale shark, it will also be necessary to consider conditions existant in the past geological ages (the period of origin of *Rhiniodon* is not known, but the closely allied family Orectolobidae is known from the Upper Jurassic to Recent) especially oceanic conditions prevalent then and during the successive ages. While Gudger's thesis is fascinating, and has hardly any facts today to substantiate it, yet it is equally feasible that the whale shark, pelagic and passive as it is having originated from one place (unknown), has at present found suitable niche in the different seas, areas where they are at present found in numbers. The latter may be feeding aggregations and we right now have little information on breeding, migration and behaviour. With our present limited knowledge, any pinpointing of the centre of origin of the whale shark will only be a matter of conjecture.

While describing a recent sensational discovery – the Megamouth – as a new species, genus and family *(Megachasma pelagios,* Family Megachasmidae) Tailor *et al.* (1983) make some pertinent remarks on the whale shark, its feeding habits and biology in relation to *Megachasma* and *Cetorhinus*. They have described the filter apparatus of *Rhiniodon* which differs from the latter two genera markedly to form dense screens, and act as more efficient filters for short suction intakes and not as a flow through system. The whale shark's behaviour of generally aligning itself vertically below the prey school which may include small crustaceans (including euphausiids), squids, anchovy and sardines and sucking in the same is reported by these authors. Hence we have some information today about the whale shark when it occurs in its feeding ground.

Deraniyagala advocates Gudger's view when he states that "the newly hatched young ones of this slow swimming, giant pelagic shark are transported from the breeding ground by current and attain a length of about 22 feet by the time they reach Ceylon." Although early juveniles have recently been caught in purse seine in the Atlantic and the Eastern Pacific from oceanic waters, more work is needed before we say anything about breeding ground and growth. Southwell's record of the gravid female from Sri Lanka waters is considered doubtful. Baughman's (1953) record of the egg case of a whale shark from the trawling ground is now considered as most probably an aborted egg. The seasonal migrations of whale shark need closer study.

Its present circumglobular distribution is interesting and its linkage between the Indo-Pacific and the Atlantic should be only *via* South African waters. Compagno (1984) reports that whale sharks apparently prefer "areas where surface temperature is 21 to 25°C with cold water of 17°C or less upwelling into it and salinity

of 34 to 34.5 ppt." This moderately lower temperature tolerance may also enable it to circumvent the Cape of Good Hope. However, it will be worthwhile to see whether any genetic heterogeneity exists in the species along its range of distribution.

Is the whale shark endangered or vulnerable?

Commercial harvesting of whale sharks is practically non-existent. In a very few areas, directed fishing is practised especially for its liver oil which is used as a preservative for the timber used in boat hulls. Gujarat waters along the northwest coast of India is a good example where a small harpoon fishery during certain years exists when the sharks occur in numbers. Off Pakistan also a similar activity is said to occur. In incidental captures, sometimes the meat is marketed fresh or is salt cured.

When there is such a low level of exploitation of this resource, one may question the appropriateness of addressing ourselves to the question whether the whale shark is endangered or vulnerable. My reasons are:

1. Our knowledge today is confined mainly to incidental captures, strandings or rammings by ships or boats.

2. Even so, data on such specimens are grossly insufficient.

3. Many sightings or captures of smaller whale sharks less than 2.5 m or 3 m may go unreported.

4. The data acquisition system is far from adequate in the tropics, except in countries such as India where we follow a multistage stratified random sampling technique for estimating the exploited resources and as such, the enumerators and field staff of the Central Marine Fisheries Research Institute may chance on specimens being caught and file a report. This system has undoubtedly increased the number of records from the Indian coastal waters many fold.

5. Decades of fishing for oceanic pelagics such as tunas and billfishes has resulted in only few sightings and captures of whale sharks.

6. Their occurrence in coastal waters in many places are very sporadic and may often be fortuitous. Rarely do we have captures in two successive years from the same area.

7. The "aggregations of upto hundreds of sharks" which Compagno (1984) mentions has not been observed in Indian coastal waters.

8. In the absence of tagging we have hardly any information about their migrations, growth, size at first maturity and longevity.

9. A major critical gap is our lack of knowledge about its reproductive potential and recruitment to juvenile and adult sizes.

10. Many gaps in our knowledge on its life history and biology have been already pointed out.

11. Other than man and his activities we are not aware of its natural enemies and predators. Diseases and internal parasites are practically unknown. Neither are we in a position to say about the effects of toxic pollutants it may assimilate through its food nor the effect of plastics, tar balls and other flotsam it may accidentally imbibe.

12. With so many unknown factors, and apparently limited numbers wherever they are known, any increase in directed effort at capture may result in great imbalance. Hence the dangers that I foresee are:

a. The more increased small–scale fisheries in island states and mainland coastal waters (neritic) using better fishing craft and gear such as purse seine and gill nets resulting in greater incidental catch or even directed fishing.

b. The large scale use of tuna purse seine in oceanic waters, especially in the Indian Ocean, where until 1981 this activity was practically nil. An explosive development is taking place now.

c. The wider use of its meat and oil if more whale sharks are landed.

13. Hitherto, its occurrence has been a rarity.

In the light of these, while I would not consider the whale shark as an endangered species at this point of time, but a highly vulnerable one. Both natural and regional co-operative research programmes may be necessary to study more about this, the largest of all fishes.

Mere recordings of occurrence unaccompanied by facts such as the exact location of capture or stranding, the time of occurrence, the length of the shark, sex etc. will be hardly helpful and so in order to facilitate

collection of proper data, I have given in the Appendix–I the information most desired (also Fig. 1). The format is the same as that given by Silas and Rajagopalan (1963). Perhaps proper documentation of such data over a period of time will help us understand more about the habits and natural history of this shark. With this in view, I appeal that readers who are able to make any fresh observations on the whale shark from Indian seas, both in coastal as well as offshore waters, communicate their findings, to the National Marine Living Resources Data Centre (NMLRDC) at the Central Marine Fisheries Research Institute, Cochin, so that the information could be collected and published from time to time. Perhaps the time has come when international collaboration in whale shark research will also have to be considered, while taking as a first task a tagging programme. A simultaneous extension programme to educate the coastal and island fishermen for data on whale sharks and the need of releasing the sharks when caught may have to be taken up. In India, this could be done through the CMFRI through its field and research staff and the Department of Fisheries of concerned maritime states and union territories.

The question may be posed as to what will all this prove, especially for a resource which is a rarity. I have no hesitation in saying that aside from our knowing more about the largest of all fishes, already whale sharks have been used as an indicator of aggregations of tuna shoals and no doubt if they are after sardines and anchovy in neritic waters we may find that they could be an equally good indicator of their forage resource or incursion of water masses into the neritic realm– cutting it short, the well being of the ecosystem.

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* Most of the references on records and systematics are listed under synonmy.

\+ For an annotated bibliography on whale shark, reference is invited to Wolfson and di Sciara (1981).

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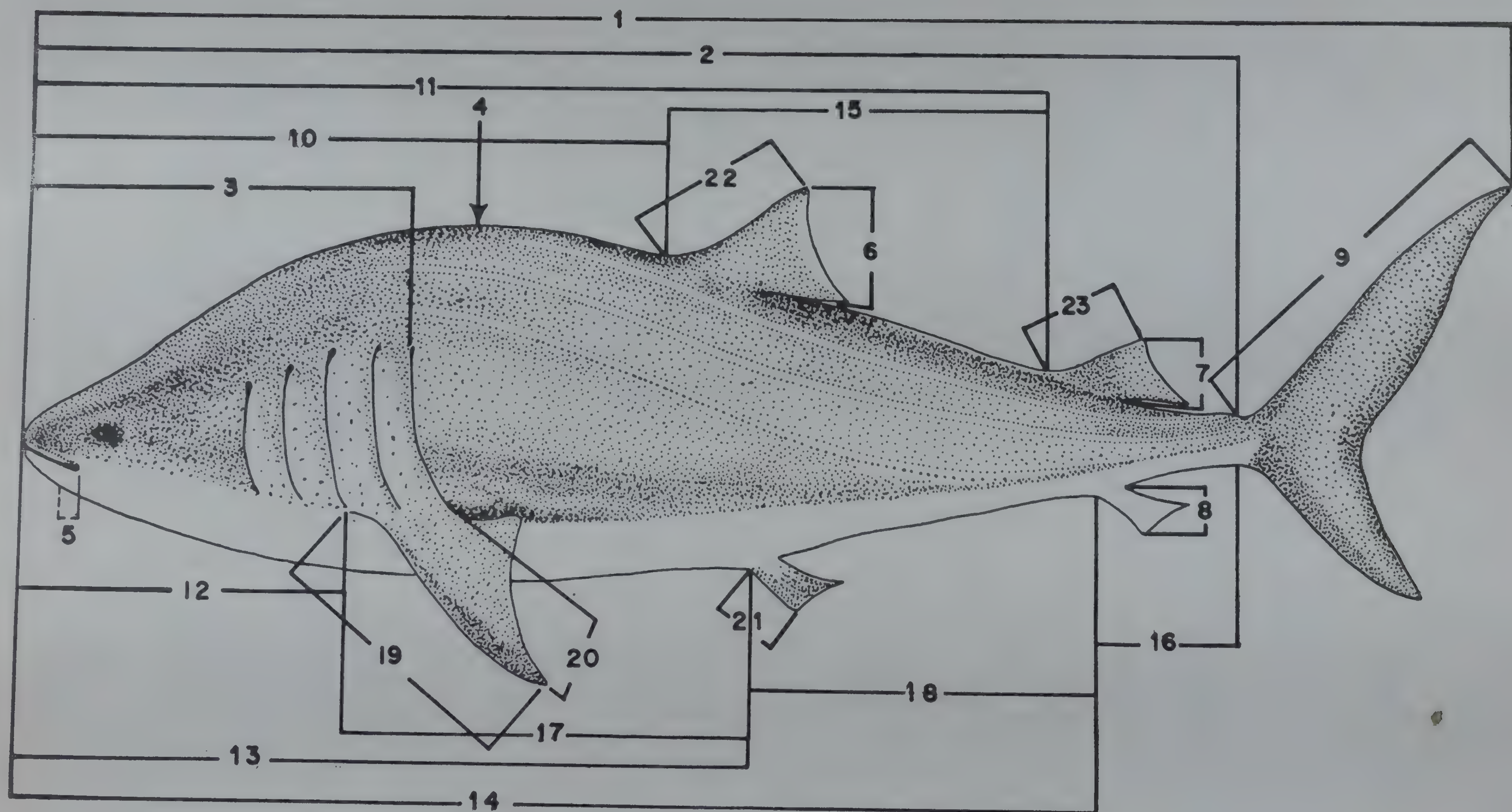

Fig. 1. Schematic diagram of lateral view of whale shark showing methodology for measurements (outline drawing after Bigelow and Schroeder, 1948) Nos. are in sequence as given in Appendix-I.

APPENDIX—I

Data

Date...Locality..
....
If captured, time and method of capture ....
If stranded, time...
If stranded, injured or infected ....
If washed ashore, dead, injured or infected ....
If sight record, location (Lat. & Long.) ....
Any other animals seen in association with the whale shark ....
Sex...Weight..
If female, any eggs (if so number)...
Length, width and thickness of egg cases...
Length of embryos (eggs and embryos to be preserved) ....
Contents of stomach (atleast sample to be preserved) ....
.... (if so, to be preserved)
Any gill parasites .... (,, ,, ,, ,,)
Any external parasites .... (,, ,, ,, ,,)

MEASUREMENTS (in metric system):

(1) Total length............................ (2) Standard length............................(3) Head length ....
(4) Girth of body at............................(5) Width of mouth from angle to angle ....

Vertical height of:

(6) First dorsal fin............................ (7) Second dorsal fin ....
(8) Anal fin............................
(9) Length of caudal fin along upper margin ....

Snout to:

(10) First dorsal............................ (11) Second dorsal .... (12) Pectoral ....
(13) Pelvic............................ (14) Anal ....

Interspace between: (15) First and second dorsals..
(16) Anal and caudal ....
(17) Pectoral and pelvic origins ....
(18) Pelvic and anal origins ....

Length of pectoral fin: (19) Along outer margin ....
(20) From angle of inner base to tip ....
(21) Length of pelvic fin ....
(22) Length of first dorsal ....
(23) Length of second dorsal...

If male: Length of clasper from inner base of pelvic fin ....
Length of pelvic fin along its inner side ....

Any additional measurements and information available ....
....

RETURN TO: NATIONAL MARINE LIVING RESOURCES DATA CENTRE,
CENTRAL MARINE FISHERIES RESEARCH INSTITUTE,
P. B. No. 2704, COCHIN - 682 031,
KERALA.

ON A WHALE SHARK *RHINEODON TYPUS* SMITH LANDED AT CUFFE PARADE BEACH, BOMBAY*

On the 8th January, 1980 a female whale shark, which got entangled in a nylon gill net (locally called 'Tarti') and let of off Alibag (about 40 nautical miles south of Bombay) at a depth of 13 m was landed alive at Cuffe Parade. The fish reportedly was caught at about 0130 hrs on 8th instant and died at about 1530 hrs, the same day (Fig. 1).

Fig. 1. Dorso-lateral view of a 7.58 m whale shark landed at Cuffe Parade, Bombay, on 8th January, 1980.

Details of morphometric measurements (in cm) recorded on the lines suggested by Silas and Rajagopalan (1963) *(J. mar. biol. Ass. India,* **5** (1): 153-157) are given below:

1.	Total length	... 758
2.	Standard length	... 622
3.	Head length	... 185
4.	Width of mouth	... 88

Vertical height of:

5.	First dorsal fin	... 84
6.	Second dorsal fin	... 58
7.	Length of caudal fin from caudal pit along upper margin	... 183

Snout to:

8.	First dorsal fin	... 375
9.	Second dorsal fin	... 533
10.	Pectoral fin	... 155
11.	Inter-space between first and second dorsals	... 137

Length of:

12.	Pectoral fin along outer margin from anterior insertion	... 144
13.	Pectoral fin from angle of inner base to tip	... 123
14.	First dorsal fin along outer margin from anterior insertion	... 87
15.	Second dorsal fin along outer margin from anterior insertion	... 52
16.	Least height of caudal peduncle	... 41
17.	Diameter of orbit	... 6.5
18.	Inter-orbital distance	... 165

Anterior margin (mid-point) of snout to:

19.	Eye	... 83
20.	Spiracle	... 108
21.	First gill opening	... 163

The colour of the specimen was dark grey with numerous yellowish white spots over the body. There was a median ridge on the back and three lateral ridges on each side.

As the local fish merchants did not evince interest to buy the fish the fishermen towed it back to the sea on the next day and sank it by tying heavy sinkers to its body.

*Reported by J. P. Karbhari, Bombay Research Centre of CMFRI, Bombay.

ON TWO JUVENILE WHALE SHARKS *RHINCODON TYPUS* SMITH CAUGHT AT MADRAS*

The present report provides details regarding two juvenile whale sharks *Rhincodon typus* Smith, one caught at Mullikuppam (Thiruvanmiyur) and the other at Royapuram, Madras.

Fig. 1. Whale shark *Rhincodon typus* Smith caught at Mullikuppam (Thiruvanmiyur).

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*Reported by: D.B. James, P. Nammalwar and S. Srinivasarengan, Madras Research Centre of CMFRI, Madras.

The first one a male whale shark measuring 740 cm was caught by the fishermen on 23–3–1980 at 0900 hrs in the shore-seine net operated by thirty persons near the inshore area at Mullikuppam. Immediately after capture, the whale shark entered the cod end of the net which was severely damaged. The shark was alive until about 1500 hrs on 23–3–1980. The second shark measuring 563 cm was landed at Royapuram on 2nd July, 1984. The morphometric measurements (in cm) of the two specimens are given below:

	Specimens 1	2
1. Total length	740	563
2. Tip of snout to origin of first dorsal fin	350	—
3. Tip of snout to origin of pectoral fin	127	129
4. Breadth of pectoral fin	83	—
5. Length of pectoral fin	—	104
6. Tip of snout to anal opening	—	325
7. Maximum height of body	111	68
8. Girth of body at head region	185	—
9. Breadth of first dorsal fin	91	53
10. Height of first dorsal fin	60	50
11. Breadth of second dorsal fin	45	27
12. Height of second dorsal fin	25	20
13. Length of upper caudal fluke	167	147
14. Length of lower caudal fluke	88	81
15. Tip of snout to first gill slit	—	96
16. Breadth of snout/head	198	63
17. Width of mouth	—	93
18. Length of first gill slit	66	60
19. Estimated weight	3.5 tonnes	2.75 tonnes

ON THE CAPTURE OF WHALE SHARKS OFF DAKSHINA KANNADA COAST*

Only stray individuals of the whale shark *Rhincodon typus* are caught occasionally along Dakshina Kannada coast. Previously they were caught in nylon gill nets. In recent years they are caught in purse seines which are extensively operated along this coast. The capture of six juvenile whale sharks in purse seines in a span of about two months between 8th November and 31st December, 1980 off Dakshina Kannada coast is reported here.

Fig. 1. A juvenile male *Rhincodon typus* 5.65 m in length caught in purse-seine 5 km off Kaup at a depth of 16 m on 20th December, 1980.

The size, sex, area and date of capture of the whale sharks are given below. (Also please see Table 1).

1. One juvenile of 6.4 m in total length, caught off Hejmadi, at a depth of 27 m on 8th November, 1980. (The sex was unknown as the fish was disposed off).

Fig. 2. The male *R. typus* caught off Kaup being hauled to the beach by fishermen using ropes.

2. A male of 6.71 m in total length, caught 9 km off Yermal, at a depth of 16 m, on 8th November 1980.
3. A male of 4.88 m in total length, caught 6.4 km off Mooloor, at a depth of 16 m, on 8th November, 1980.

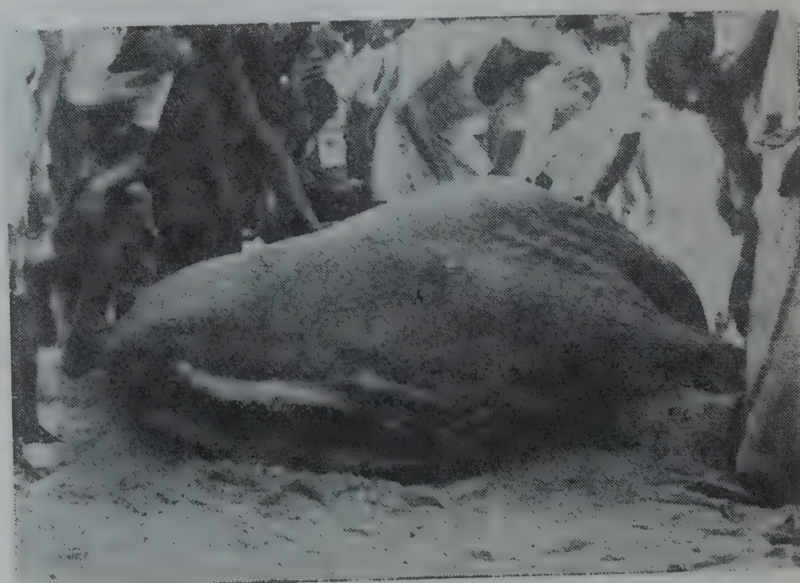


Fig. 3. The anterior portion of the male *Rhincodon typus* 6.71 m in length caught 9 km off Yermal in purse-seine at a depth of 16 m on 8th November, 1980.

4. A male of 5.65 m in total length, caught 5 km off Kaup, at a depth of 16 m, on 8th November, 1980.
5. A female of 7.92 m in total length, caught 9 km off Malpe, at a depth of 16 m, on 27th December, 1980.

Fig. 4. Front view of head of the female *R. typus* caught off Malpe showing broad mouth on being hauled ashore.

*Prepared by K. Satyanarayana Rao, Tuticorin Research Centre of CMFRI, Tuticorin.

Table 1. *Data on six whale sharks* Rhincodon typus *caught along Dakshina Kannada coast*

Particulars | Sl. No. of whale sharks→	1	2	3	4	5	6
1. Date of capture	8th Nov. '80	8th Dec. '80	8th Dec .'80	8th Dec. '80	27th Dec. '80	31st Dec. '80*
2. Locality and depth	15 km off Hejmadi at depth of 27 m	9 km off Yermal at depth of 16 m	6.4 km off Mooloor at depth of 16 m	5 km off Kaup at depth of of 16 m	9 km off Malpe at depth of 16 m	12 km off Malpe at depth of 22 m
3. If captured, time and method of capture	Captured at 12 hrs in purse seine	Captured at 16 hrs in purse seine	Captured at 12 hrs in purse seine	Captured at 11 hrs in purse seine	Captured at 12 hrs in purse seine, landed at 16 hrs	Captured at 12 hrs in purse seine, landed at 17 hrs
4. If stranded, time	Not stranded	Not stranded	Not stranded	Not stranded	Not stranded	Not stranded
5. If stranded, injured or infected	—	—	—	—	—	—
6. If washed ashore, dead, injured or infected	—	—	—	—	—	—
7. If sight record, location	—	—	—	—	—	—
8. Fishing vessel which caught the whale shark and size of vessel	Purse seiner (43' vessel)	*Yermal Fisheries* (Purse seiner 43' vessel)	*Mooloor Fisheries* (Purse seiner 43' vessel)	*Maha-lakshmi* (Purse seiner 43' vessel)	*Prithi Enterprises* (Purse seiner 43' vessel)	*Rajeswari* (Purse seiner 43' vessel)
9. Owner of the fishing vessel	—	Shri K. Suvarna	30 ex-rampan fishermen	Shri Krishnappa, Kotian and 19 others	10 men of fishermen community (Not ex-rampan fishermen)	—

Particulars | Sl. No. of whale sharks→	1	2	3	4	5	6
10. Merchant who purchased the whale shark	—	Shri Ahmed Saheb	Shri Ahmed Saheb	Shri S. Kasper of M/s. Anthonyappa & Co., Muttom	Smt. Radha Devi Karkera	Smt. Jalajakshmi Karkera
11. Price paid by the merchant	Rs. 300/- claimed but none purchased	Rs. 300/-	Rs. 250/-	Rs. 250/-	Rs. 200/-	Rs. 50/-
12. Amount incurred by the merchant for hauling and cutting of whale shark	—	Rs. 200/-	Rs. 150/-	Rs. 100/-	Rs. 200/-	Rs. 200/-
13. Quantity of salt used for curing (kg)	—	1,000	800	1,000	2,000	1,000
14. Sex	—	Male	Male	Male	Female	Male
15. Weight (approximate) (kg)	—	1,800	1,250	1,500	4,000	1,700
16. If female, any eggs present, if so number	—	—	—	—	ovary immature	—
17. Length, width and thickness of egg cases	—	—	—	—	—	—
18. Contents of stomach (at least sample to be preserved)	—	—	—	Data given in Table 2	Data given in Table 2	Could not be collected
19. Any stomach, intestinal or other internal parasites	—	Not present	Not present	Not present	Not present	—
20. Any gill parasites	—	Not present	Not present	Not present	Not present	—

Particulars | Sl. No. of whale sharks→	1	2	3	4	5	6
21. Any external parasites	—	Not present	Not present	Not present	Not present	—
22. Weight of fresh meat (kg)	—	1,200	800	1,000	2,600	1,300
23. Weight after drying (kg)	—	350	250	300	800	420
24. Weight of liver (kg)	—	140	80	100	240	80
25. Quantity of oil extracted (l)	—	58	Liver discarded as oil was not of good quality	49.5	72	54
26. Any other animals seen in association with whale shark	—	—	—	—	Got 2.5 tonnes of oil sardine with whale shark	—
Morphometric data**						
1. Total length	6400	6705	4880	5650	7920	5180
2. Standard length	—	5030 (75.0)	—	4220 (74.7)	5930 (74.9)	—
3. Length of head	—	1800 (26.8)	—	1455 (25.8)	1890 (23.9)	—
4. Girth of body	—	389 (58.0)	—	3640 (64.4)	4400 (55.6)	—
5. Width of mouth from angle to angle	—	840 (12.5)	—	780 (13.8)	1180 (14.9)	—
6. Diameter of eye	—	40 (0.6)	—	—	44 (0.6)	—
7. Interorbital distance	—	1300 (19.4)	—	—	145 (018.3)	—
8. Snout to eye	—	700 (10.4)	—	—	790 (10.0)	—

Particulars | Sl. No. of whale shark→	1	2	3	4	5	6
9. Snout to spiracle	—	800 (11.9)	—	—	890 (11.2)	—
10. Snout to 1st gill opening	—	1420 (21.2)	—	—	1700 (21.5)	—
11. Length of pelvic fin	—	420 (6.3)	350 (7.2)	340 (6.0)	380 (4.8)	—
12. Length of first dorsal fin	—	710 (10.6)	660 (13.5)	770 (13.6)	820 (10.4)	—
13. Length of second dorsal fin	—	250 (3.7)	200 (4.1)	310 (5.5)	380 (4.8)	—
14. Range of thickness of body wall	—	40–90 (0.6–1.3)			65–130 (0.8–1.6)	—
Vertical height of:						
15. First dorsal fin	—	640 (9.6)	520 (10.7)	690 (12.2)	739 (9.3)	—
16. Second dorsal fin	—	250 (3.7)	230 (4.7)	310 (5.5)	319 (4.0)	—
17. Anal fin	—	250 (3.7)	—	220 (3.9)	284 (3.6)	—
18. Length of caudal fin from caudal pit along upper margin	—	1400 (20.9)	1330 (27.3)	1415 (25.0)	1830 (23.1)	—
Snout to:						
19. First dorsal fin	—	3090 (46.1)	—	2620 (46.4)	3286 (41.5)	—
20. Second dorsal fin	—	—	—	3750 (66.4)	5160 (65.2)	—
21. Pectoral fin	—	1750 (26.1)	—	1070 (18.9)	1910 (24.1)	—
22. Pelvic fin	—	—	—	2930 (51.9)	3720 (47.0)	—
23. Anal fin	—	—	—	3845 (68.0)	5305 (67.0)	—
Interspace between:						
24. First and second dorsal fins	—	—	—	980 (17.3)	1857 (23.4)	—
25. Anal and caudal fins	—	—	—	—	823 (10.4)	—

Particulars | Sl. No. of whale sharks→	1	2	3	4	5	6
26. Origins of pectoral and pelvic fins	—	—	—	—	2190 (27.7)	—
27. Origins of pelvic and anal fins	—	—	—	—	1537 (19.4)	—
Length of pectoral fin:						
28. Along outer margin from anterior insertion	—	1100 (16.4)	920 (18.9)	1090 (19.3)	1190 (15.0)	—
29. From angle of inner base to tip	—	850 (12.7)	880 (18.0)	836 (14.8)	1020 (12.9)	—
If male:						
30. Length of clasper from inner base of pelvic fin	—	250 (3.7)	—	220 (3.9)	—	—
31. Length of pelvic fin along its inner edge	—	280 (4.2)	—	190 (3.4)	—	—

* This particular whale shark was caught by 42½′ purse seiner *Hemalatha* (owned by Shri Somappa Kotian and party) 12 km off Gangolli at a depth of 22 m on 29th December, 1980 at 16 hrs and brought to Malpe on the same day at 18 hrs. But it was released in the sea 12 km off Malpe where the depth was 22 m on 30th December as workers demanded Rs. 200/- to haul the shark ashore. The same whale shark was captured by *Rajeswari* on 31–12–1980.

** Measurements in mm. Figures given in brackets are measurements expressed as percentage in total length.

6. A male of 5.18 m in total length, caught 12 km off Malpe, at a depth of 22m, on 31st December, 1980. There were no parasites on any of the sharks.

Capture of whale sharks: The fishermen reported that the whale shark swims slowly at or near the surface of water and follows shoals of fishes for feeding on them. On capture in the purse-seine, the fishermen put a noose around the caudal peduncle, tie a knot firmly around it and tow the shark to the shore using carrier boat. On reaching the coast, they haul the huge fish to the beach using ropes which are used for beaching mechanised boats. Only one purse seine in which a female was caught off Malpe on 27th December was partly damaged. The whale shark is usually docile. It makes lashing movements for about an hour on being hauled to the beach.

Causes of occurrence of whale sharks in coastal waters: In November–December, oil sardine, anchovies and mackerel are obtained in purse seines from the area. The whale sharks may enter the shallow coastal waters for feeding on shoals of these pelagic fishes. *Rhincodon typus* is normally a plankton feeder with the well developed gill apparatus for straining planktonic organisms like a sieve but they are also known to feed on fishes. The gut contents of whale sharks caught off Kaup on 20th December and off Malpe on 27th December consisted of *Stolephorus devisi, Kowala coval,* copepods and other zooplankters, phytoplankton and sand grains (Table 2).

The period October–March is one when zooplankton is abundant off Dakshina Kannada coast. It is

Fig. 5. The stomach and long, thick liver lobes of the female whale shark caught off Malpe as cut and exposed.

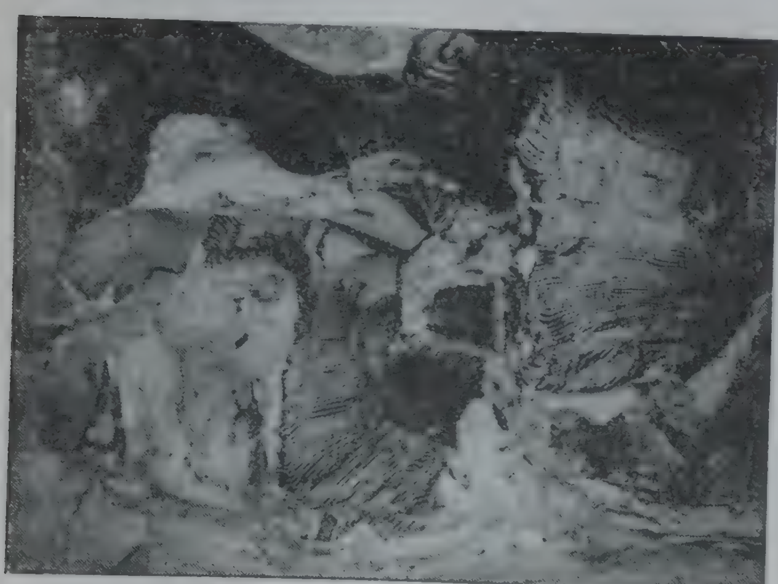


Fig. 6. The gills of *R. typus* caught off Malpe as cut and exposed.

Figs. 7 & 8. The flesh of *R. typus* caught off Kaup being cut for curing.

Table 2. *Data on stomach contents of whale sharks landed at Kaup and Malpe*

Particulars | Sl. No. of whale sharks→	4	5
Date of capture	20th December, 1980	27th December, 1980
Volume of fluid in stomach	24 litres	38 litres
Volume of stomach contents	355. 2 ml	1128.4 ml
Percentage of different items of stomach contents:		
Stolephorus devisi	78.3	57.1
Kowala coval	—	25.3
Zooplankton (copepods and other zooplankters in advanced stage of digestion)	16.1	12.8
Phytoplankton (in advanced stage of digestion)	4.4	2.2
Sand grains	1.2	2.6

possible that the migration of whale sharks to coastal waters is influenced by this factor also.

Utilization: Meat ranging in weight from 0.8 tonne to 2.6 tonnes, the latter from the whale shark weighing 4.0 tonnes, was got from the sharks landed. The fish merchants paid Rs. 50/- to 250/- per whale shark (Table 1) and incurred additional expenditure for cutting the fish and curing. The meat which was white and soft was salted, kept for seven to eight days and then dried. Water content of meat was very high being 68.8 to 70.8 per cent. Whale shark meat is not eaten locally. The cured meat was sent to Shimoga, Chickmagalur, Bangalore, Cannanore, Kottayam, Changanacherry, Alleppey and Ernakulam where there was demand. The cured meat fetched a price of Rs. 4/- per kg. The liver oil extracted by heating is used for giving a preservative coating to wooden boats. In addition, it is also used in the manufacture of shoe polish. The shoe polish manufacturing companies purchased the liver oil at a price of Rs. 20/- per tin of 16 litres.

ON THE LANDING OF A WHALE SHARK *RHINCODON TYPUS* SMITH AT ANJUNA, GOA*

On 29-1-1981 at about 0300 hrs. a female whale shark weighing 2.2 tonnes was entangled in a nylon gill net operated by fishermen off Anjuna, Goa at a depth of 27 m. The shark was towed ashore with the help of 16 fishermen from four canoes. This is the first record of *Rhincodon typus* from this area. Details of morphometric measurements of the species (in cm) are given below:

1.	Total length ...	570
2.	Standard length ...	455
3.	Girth of body (maximum) ...	255
4.	Width of mouth (angle to angle)	90
5.	Vertical height of first dorsal fin ...	95
6.	Vertical height of second dorsal fin ...	55
7.	Length of caudal fin from caudal pit along upper margin ...	145
8.	Length of caudal fin from caudal pit along lower margin ...	90
9.	Snout to first dorsal fin ...	265
10.	Snout to second dorsal fin ...	400
11.	Snout to pectoral fin ...	135
12.	Snout to first gill opening ...	120
13.	Inter-space between first and second dorsal fins ...	67

The liver of the shark weighed 50 kg and yielded 20 litres of quality oil and five litres of mixed poor quality oil.

*Reported by P. V. Doiphode, Directorate of Fisheries, Panaji, Goa

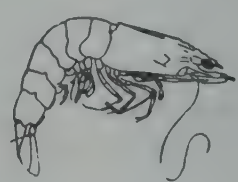
NOTE ON THE OCCURRENCE OF THE WHALE SHARK *RHINCODON TYPUS* SMITH OFF VERAVAL COAST*

In the course of observations at the trawler landing centre (Bhidiya) at Veraval, the author observed the landing of nine specimens of the whale shark, *Rhincodon typus* Smith on 12–4–1982. On enquiry it was found that the sharks were not caught by accident in the nets but were hunted. The sharks were caught by manually throwing heavy hooks (similar to harpooning). As soon as the hook penetrated into the body of the shark it was towed to the harbour in live condition. At the harbour the abdomen was cut open and the liver was removed. After removing the liver the carcass was towed back into the sea as the flesh had no demand in the local markets. The oil is generally used for painting boats and other wooden fishing appliances.

It was not possible to take any morphometric measurements of the specimens as there was no way of bringing the fish to the warf. Only one specimen of 950 cm in total length could be measured which yielded about 500 kg of liver. It is generally believed that the liver of these sharks formed about 10% of the total body weight. On this basis the weight of this shark was estimated at five tonnes. All the nine sharks landed on 12–4–'82 were of the same size or slightly smaller (ranging in total length from 900–950 cm). Landing of whale sharks was also observed on 13–4–'82 (7 Nos.), 14–4–'82 (4 Nos.) and 15–4–'82 (2 Nos.). Thus during a period of four days, landing of a total of 22 sharks could be observed. However, enquiries with the fishermen indicated landing of 40 Nos. of these sharks during this period. Fishermen further informed that a number of these sharks were sighted in the sea during the period from 10–4–'82 to 15–4–'82. It was also gathered that whale shark is a regular visitor of this coast during April and the fishermen who are in need of the oil, hunt them during this period. The present observation is significant in that about 40 numbers of these sharks were caught in just four days.

In the present instance no data on the biology could be collected as there was no way of bringing the specimen out of water.

*Reported by G. Sudhakara Rao, Veraval Research Centre of CMFRI, Veraval.

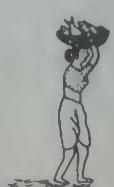


REPORT ON THE CATCH OF A JUVENILE WHALE SHARK *RHINCODON TYPUS* SMITH AT KEELAKARAI, GULF OF MANNAR*

A juvenile whale shark measuring 3.15 m in total length was caught at 0500 hrs on 7–2–'83 in the gill net *(Pachivalai)* operated by a 9 m mechanised boat off Keelakarai. It was estimated to weigh about 1.5 tonnes.

The whale shark was cut into pieces immediately after the landing and burried in the seashore on 7–2–'83. Therefore, morphometric measurements and photograph of the whale shark could not be taken. However, on 8–2–'83, it was exhumed, and from the remains of the head and the caudal flukes the specimen was identified as *Rhincodon typus* Smith.

*Reported by P. Nammalwar, Mandapam Regional Centre of CMFRI, Mandapam.



ON THE LARGEST WHALE SHARK *RHINCODON TYPUS* SMITH LANDED ALIVE AT CUFFE PARADE, BOMBAY*

The most publicised whale shark, *Rhincodon typus* Smith, which reportedly got entangled in the midwater gill net *(waghra)*, operated in 33 m. depth off Khanderi light house (lat. 18° 42′ N long. 72° 48′ E) about 26 nautical miles south of Bombay, on the west coast of India was landed alive at Cuffe Parade, on 21st November, 1983 (Fig. 3). (Please see photograph on back cover)

Fig. 1. The whale shark completely wrapped in gill net with floa s. The shark was brought by three 20 footer mechanised boats seen in the back ground.

On 20–11–1983, at about 1400 hrs a 20 footer mechanised fishing boat named *Maya Prasad* fitted with an engine of 16 H.P. steamed out for gill net fishing from Cuffe Parade under the Captainship of Shri Jagannath Balakrishna Dhanu. The boat reached the fishing ground at about 1700 hrs on the same day. As usual, five fishermen of the boat paid out 36 units of gill net at about 1730 hrs. Earlier, the fishermen had noticed some surface-floating huge fish causing considerable damages to their surface set gill nets. To avoid further damage, the fishermen temporarily switched on to the operation of midwater gill net by attaching few more sinkers to their nets. The crews of *Maya Prasad* gill netter were terribly frightened as their boat started dragging away from its position at about 2330 hrs when the high tide was 4.60 m, 20th instant being a full-moon day. They were at a loss to understand as to what exactly had happened but roughly guessed that some huge fish had got entangled in their net. Realising a grave risk to their life and property in the sea, the boat crews shouted and light signalled for outside help. Two other nearby mechanised fishing boats namely *Rohini Prasad* (30 H.P.) and *Sainath Prasad* (18 H.P.) immediately rushed to the rescue of the boat in danger. On finding that the net was torn to shreds and it got wound around the body of a whale shark, fifteen crew of the three boats had to battle with the monster for about two and a half hours to overpower and securely tie the shark with strong nylon ropes. (Figs. 7 & 8). The shark after being fully wrapped in 17 gill-net units was completely brought under control and was successfully towed alive to Cuffe Parade beach at about 1000 hrs on 21–11–1983, during high tide, (Figs. 1 & 2). The struggle put up by the shark was so hard that it took about eight hours for three mechanised boats, in unision, to land it at Cuffe Parade. The shark after being alive for about fourteen hours died at about 1330 hrs on 21st instant, when the high tide water receded. The carcase was then completely disentangled from nets and ropes by twentyfive fishermen taking about two hours. (Figs. 9 & 10).

The news of the beaching of a leviathan at Cuffe Parade spread like wild fire throughout the length and

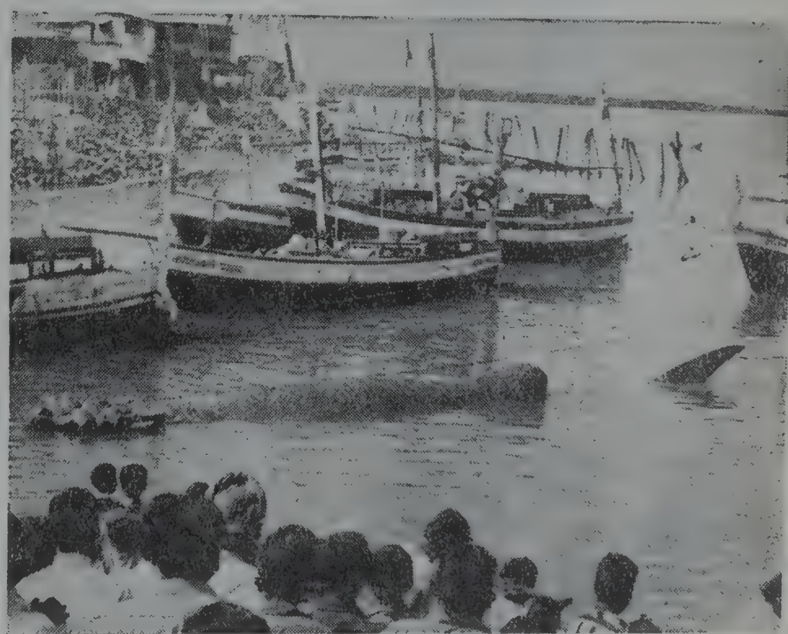


Fig. 2. The whale shark in water at Cuffe Parade after it was towed alive by 20 footer mechanised boats.

breadth of the cosmopclitan city of Bombay through local news papers, radio and television. People from all walks of life thronged at Cuffe Parade to have a glimpse of the giant sea creature and the crowed was so huge and unmanagable that special traffic squad was pressed into emergency service to clear and control the mas-

*Prepared by J. P. Karbhari and C. J. Josekutty, Bombay Research Centre of CMFRI, Bombay.

sive traffic jam. Some orthodox people paid homage to the unbelievably collosal sea creature by showering flowers, rice and vermilion and burning incense sticks. The shark was cordoned off by the local police.

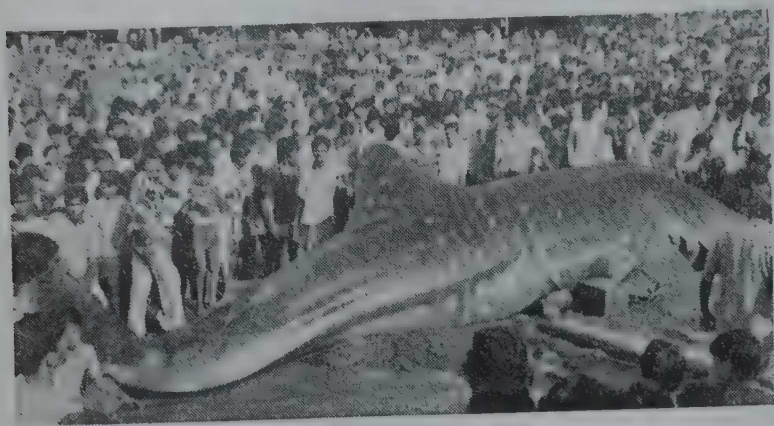


Fig. 3. Dorso-lateral view of the whale shark caught alive in the fishing net near Khanderi Light House, on the Konkan coast of Maharashtra.

Fig. 4. Dorso-lateral view of the whale shark showing the close-up view of longitudinal lateral ridges or body keels.

The staff of Bombay Research Centre of CMFRI immediately arrived at Cuffe Parade and identified the shark as *Rhincodon typus* Smith – the whale shark. The authors strived for two days (21st and 22nd November 1983) to collect all possible data on the morphometry and the anatomy of the fish. The methodology adopted for the collection of morphometric data was as per the guidelines given by Silas and Rajagopalan (1963). The detailed morphometric measurements (in m) of the whale shark are given below:

1. Total length	... 12.18
2. Standard length	... 10.23
3. Head length	... 2.14
4. Girth of body at P1 base	... 5.05
5. Width of mouth from angle to angle	... 1.36

Vertical height of:

6. First dorsal fin	... 1.37
7. Second dorsal fin	... 0.48
8. Anal fin	... 0.34
9. Length of caudal fin from caudal pit along upper margin	... 1.95

Snout to:

10. First dorsal fin	... 4.08
11. Second dorsal fin	... 6.95
12. Pectoral fin	... 1.79
13. Pelvic fin	... 4.48
14. Anal fin	... 7.45

Interspace between:

15. First and second dorsals	... 2.80
16. Anal and caudal	... 0.98
17. Pectoral and pelvic origins	... 2.68
18. Pelvic and anal origins	... 3.08

Length of:

19. Pectoral fin along outer margin from anterior insertion	... 2.16
20. Pectoral fin from angle of inner margin to tip	... 1.78
21. Pelvic fin along outer margin from anterior insertion	... 0.65
22. First dorsal fin along outer margin from anterior insertion	... 1.55
23. Second dorsal fin along outer margin from anterior insertion	... 0.65
24. Length of clasper from inner base of pelvic fin	... 0.78
25. Length of pelvic fin along its inner edge	... 0.55
26. Interspace between eye and spiracle	... 0.19
27. Interspace between eye and angle of jaw	... 0.25
28. Diameter of eye ball	... 0.03
29. Diameter of orbit	... 0.07
30 Inter-orbital distance	... 1.98
31. Width of the mouth straight across inside from angle to angle of jaws	... 1.18

Description

The body had a hump-backed appearance and the caudal fin measured about two metres. There was a marked concavity at the inter-orbital space

(Fig. 5) which marked the flat wedge shaped form of the head. When seen or photographed in profile, it gave a deceptive fusiform appearance. Eventhough it has been reported that a furrow connecting the nostril to the mouth is absent in the adult, in the present adult whale shark, it was observed that the nasal flaps were well developed and extended in a crescentic fold from the nostril to under the rim of the lip (Fig. 5).

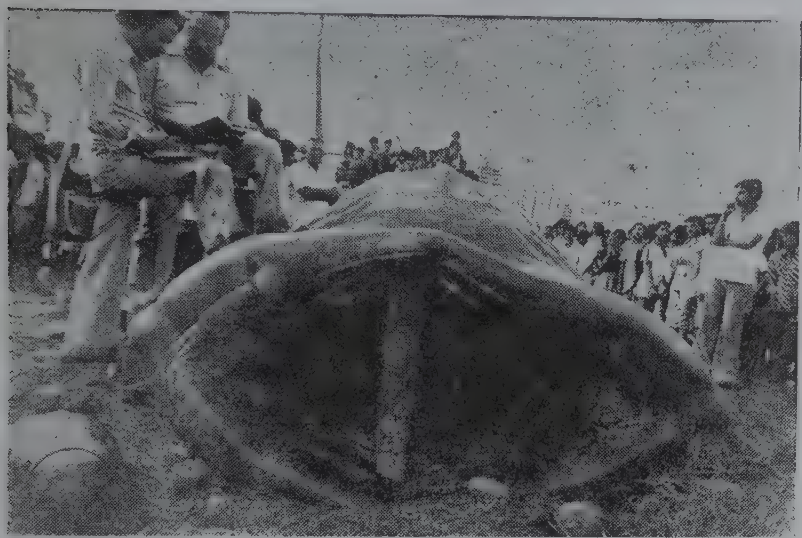


Fig. 5. Frontal view of the whale shark. Note the enormous gape. The width of the capacious mouth is 1.18 m. The Institute staff of Bombay Research Centre of CMFRI is seen in the background recording morphometric data. Also note the marked concavity of the inter-orbital space and the well developed nasal flaps extending into a crescentic fold from the nostril to under the rim of the lip.

Three distinct longitudinal lateral ridges or body keels were present on either side of the body. A dorso-lateral keel commencing above the branchiae extended to below the second dorsal and a median keel commencing anterior to the first dorsal extended to the region of the tail. The third, the lowest keel was the strongest and most pronounced. It commenced behind the last gill-silt and reached up to the tail, coalescing there with the keel on its axis (Figs. 4 & 6). The snout was obtuse and depressed and the mouth was terminal and cavernous. The angle of the gape was tad-pole like and terminated in front of the eyes. The colour of the specimen was deep purplish-blue dorsally and the under surface was reddish-white. The same flush of red was visible under the head and on the margins of the fins.

Fig. 6. Frontal view of the whale shark showing the close-up view of lateral rudges or body keels and their origin.

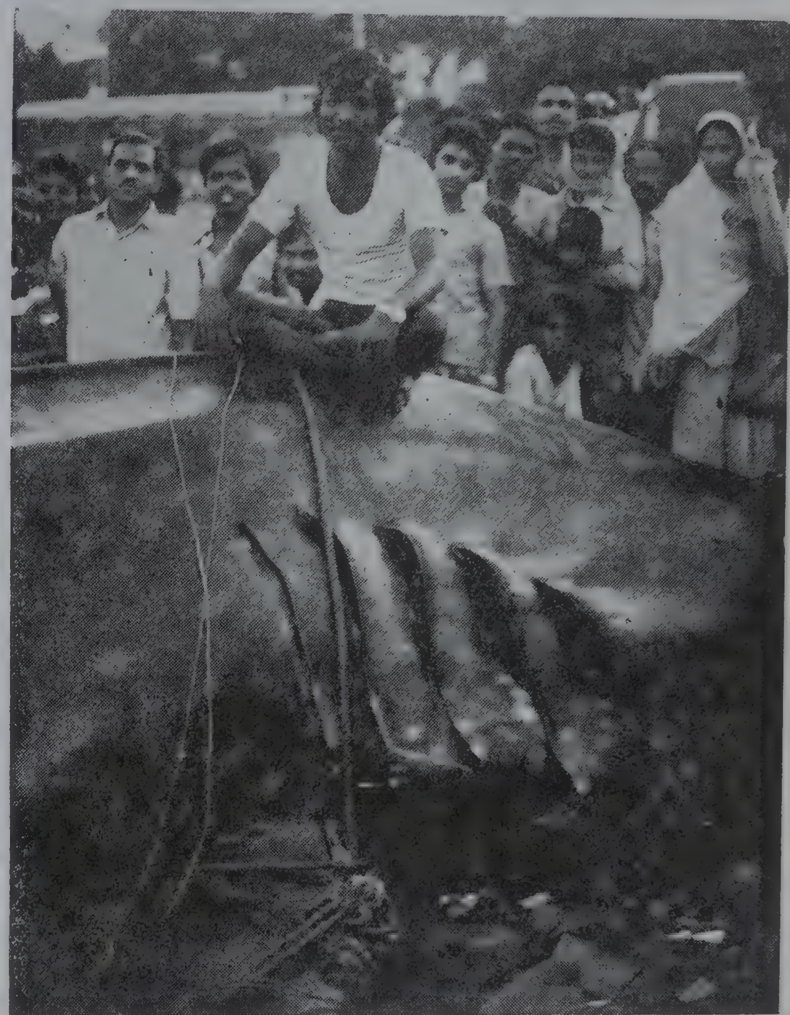


Fig. 7. Showing the ingenuity of the fishermen in securedly tying the whale shark with strong nylon rope near the gill slit region.

The dorsal surface and the head were covered with a profusion of white spots which were arranged in a regular series of 23 vertical rows. In each alternate row the spots were fainter and tended to coalesce into linear markings, so that as a whole, the markings presented a pattern of rows of large, well spaced spots, alternating with linear bands. The anterior dorsal fin was spotted and faintly marked with transverse lines produced by coalescing of spots. Second dorsal was without spots, pectorals profusely and caudals sparsely spotted (Fig. 10). On the head, spots were more pronounced and formed a kind of mosaic (Fig. 9).

Fig. 8. The whale shark tied with nylon rope near the caudalpit.

Myraid of small rasp-like teeth were arranged in vertical rows on the toothband in each jaw. In appearance and feeling, the teeth in the bands were all pointing backward. One specimen of sucker fish *Remora remora* found firmly clinging to the upper palate, well inside the buccal cavity of the whale shark was collected and preserved by the authors. The tongue was large and flat. The specimen was an adult male and a pair of well developed copulatory organs called claspers extended backwards as far as the hind edge of the ventral as described by Prater (1941).

Disposal of the whale shark

The fishermen were confused after landing such a huge shark and were planning to dispose off the carcass by towing it back into the sea. On receipt of the proper and timely guidance from the authors, the entire animal was sold out for Rs. 4000/- to a local fish merchant (M/s Afzal Fisheries) who arranged to cut up for curing on 22–11–1983. Eight persons working for 10 hours (from 0800 to 1800 hrs.) could complete this stupendous task of fish disposal. The flesh was cut up into 475 big pieces each weighing about 20 kg. Thus the total weight of the glistening white soft flesh along with the cartilageous vertebrae and skin was approximately estimated at 9,500 kg. The flesh was cured by using 2,400 kg of salt, costing Rs. 750/-. The cured flesh was sold out for Rs. 6,250/- to M/s A. Sankara Appa of Secunderabad (Andhra Pradesh). During salt curing the brine formed was approximately equal in volume to that of the flesh cured, which was quite an unusual phenomenon.

The liver of the fish was shared equitably between the fishermen and the fish merchant. The fish merchant sold his share of liver (510 kg) to a shark liver oil extracting plant (Haffkine Biopharmaseutical Corporation Ltd., Sasoon Dock, Bombay) who had extracted 255 litres of liver oil. Data for oil analysis furnished by the above plant revealed that the oil was deficient in Vitamin A, potency being 6000 I/U per gm and Free Fatty Acid (FFA) being 1.6. The fishermen had received 508 kg of liver as their share and they had extracted oil in a crude form by heating. The fishermen use the oil against some skin diseases and as a preservative for their fishing crafts. The total weight of the liver was estimated at 1,018 kg.

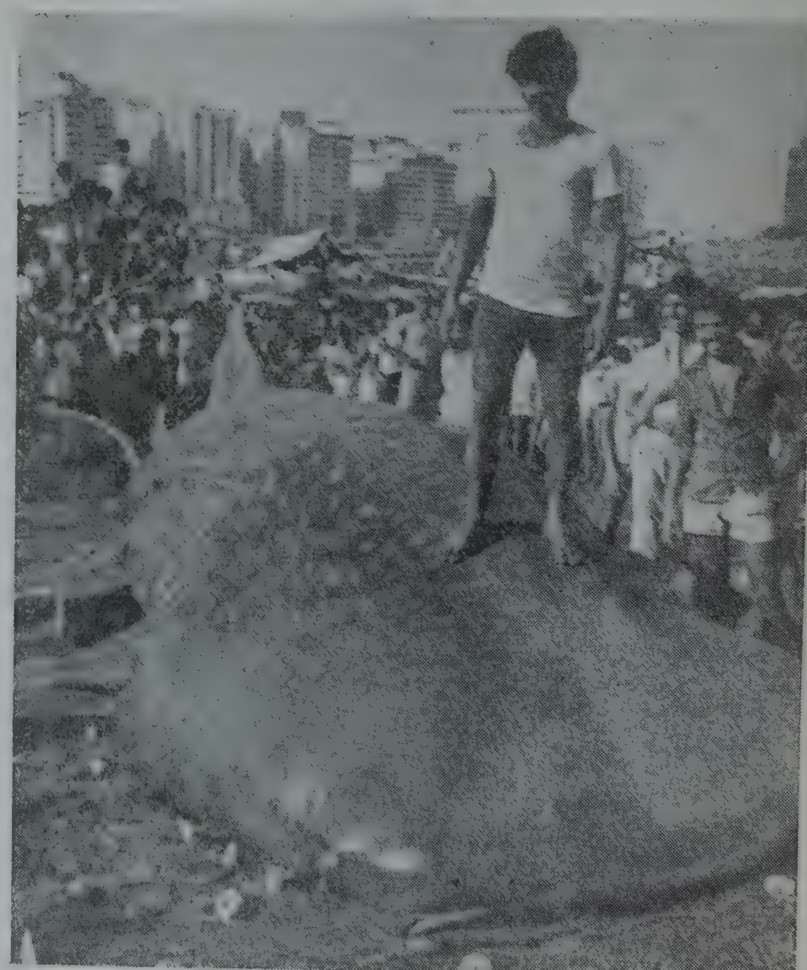


Fig. 9. Frontal view of the whale shark. Note the mosaic pattern of spots on the head. The gill net with floats are lying by the side of the shark. The captor Shri J. B. Dhanu is seen atop the whale shark.

The total weight of the viscera along with its gut contents, fins, gill arches with gill and gill-rackers was estimated at about 500 kg. The total weight of the whale shark was, thus, approximately estimated at 11,018 kg.

Fig. 10. The fishermen helping the CMFRI staff in taking various body measurements of the shark. Note the sparsely spotted caudal fin. A great crowed of people assembled round the shark is also seen.

Anatomical characteristics of the fish

The fish was cut up from dorsal side as it was originally lying in the same position with the ventral portion touching the sandy beach. Further, the weight of the fish was pausing a problem to turn it even slightly. One peculiarity noted was that any incision made in the body of this fish rapidly closed up and left no trace of the cut probably due to the resilience of the skin and the deep underlying layers of fat, as was observed by Gogote and reported by Prater (1941) in his description on a 20 feet long whale shark caught near Jayagad, Ratnagiri (Maharashtra) on October 3rd, 1936.

The thickness of the skin along dorsum and abdominal wall was 148 mm and 98 mm respectively. The flesh was soft and whitish in colour as was observed by Chacko and Mathew (1954).

The gill rackers were closely set in a row on the inner extrimity of the gill-arches and they projected towards the inner gill-cleft leading into the gullet. The closely set pectinate gill-rackers appeared to be covered by highly vascular tissues as large quantity of blood was seen oozing out when they were cut and removed as a waste. When the viscera of the shark was exposed and the stomach open, large quantity of water gushed out which probably the shark had apparently taken during its long struggle in the net. The analysis of the stomach contents in the field itself revealed that it included varied items such as large quantities of seaweeds and algae, partly digested remains of fish, crustaceans, molluscs etc. It was interesting to note that one suckerfish, *Remora remora,* measuring 208 mm in total length was found in the stomach of the whale shark, probably ingested accidentally.

The unique event of the capture and landing of 12.18 m long and live whale shark locally called *massa* by the traditional fishermen of Cuffe Parade, Bombay, has been widely publicised. The largest specimen obtained so far, on the Indian coasts measured 12.10 m (Kakikini *et al.,* 1959). Though the whale shark is known to attain a length of 18.3 m based on a specimen captured on the east coast of the Gulf of Siam (Smith, 1925) as given by Prater (1941), the Guinness Book of Animal – Facts and Feats (1976) has recorded a whale shark of 11.58 m killed by Captain Charles Thompson and some local fishermen just below Knight's Key, South Florida, U.S.A. in May, 1912 as the largest. From the above published records, it certainly appears that the present specimen of whale shark of 12.18 m at Bombay (India) is an unsually large one.

The authors are greatly thankful and deeply indebted to Dr. E. G. Silas, former Director, Central Marine Fisheries Research Institute, Cochin for his deep interest and valuable guidance in the preparation of this account. We are also thankful to Dr. S. Ramamurthy, Officer-in-Charge, Bombay Research Centre of CMFRI for his encouragement. We express our thanks to S/Shri K. G. Waghmare and M. Sriram for their help.

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NOTE ON A WHALE SHARK *RINCODON TYPUS* SMITH LANDED AT PONDICHERRY*

A juvenile male whale shark *Rhincodon typus* Smith was captured by the Solathandavankuppam fishermen of Pondicherry State on 30th January, 1984 at 0530 hrs in gill net (13 cm mesh size *kattu valai)* operated by a 9 m long mechanised boat near Marakkanam (off Eggikuppam) at about 40–45 m water depth. The net was partly damaged while bringing the whale shark by the mechanised boat to the shore at 1030 hrs. The morphometic measurements (in cm) of the whale shark are as follows:

1. Total length (Snout to caudal tip) ... 497
2. Standard length (Snout to caudal pit) ... 375
3. Snout to origin of first dorsal ... 218
4. Snout to first gill opening ... 75
5. Width of head ... 100
6. Eye diameter ... 3.5
7. Width of mouth ... 68
8. Length of anterior gill opening ... 60
9. Length of posterior gill opening ... 30
10. Length of first dorsal fin ... 60
11. Length of pectoral fin ... 80
12. Length of second dorsal fin ... 25
13. Length of ventral fin ... 24
14. Length of caudal fin (upper) ... 122
15. Length of caudal fiin (lower) ... 122

Anal fin could not be measured due to scar.

*Reported by L. Chidambaram, Pondicherry Field Centre of CMFRI, Pondicherry.

ON A JUVENILE WHALE SHARK *RHINCODON TYPUS* SMITH LANDED AT COCHIN*

An immature female whale shark of 1.5 tonnes was caught about 20 km southwest of Cochin on 17–12–1984 between 2 and 3 hrs in a gill net at a depth of about 30 m. The stomach of the shark was empty and water gushed out when slit open. No internal, gill or external parasites were found. The following body measurements (in cm) have been recorded.

1. Total length ... 360
2. Standard length ... 265
3. Head length ... 88

Height of body at:

4. pectoral base ... 56
5. second dorsal ... 24
6. caudal peduncle ... 16
7. Width of mouth from angle to angle ... 56

Vertical height of:

8. first dorsal ... 34
9. second dorsal ... 13
10. anal ... 12
11. Length of caudal fin from caudal pit along upper margin ... 88

Snout to:

12. first dorsal ... 154
13. second dorsal ... 219
14. pectoral ... 82
15. pelvic ... 191
16. anal ... 241
17. spiracle ... 34
18. first gill opening ... 62
19. second gill opening ... 73
20. third gill opening ... 82
21. fourth gill opening ... 85
22. fifth gill opening ... 88

Interspace between:

23. first and second dorsals ... 65
24. anal and caudal ... 24
25. pectoral and pelvic ... 109
26. pelvic and anal ... 50

*Reported by K. V. Somasekharan Nair, A. A. Jayaprakash and V. A. Narayanankutty, CMFRI, Cochin.

Length of:

27.	pectoral fin along outer margin from anterior insertion ...	66
28.	pelvic fin from anterior insertion ...	18
29.	first dorsal from anterior insertion ...	36
30.	second dorsal from anterior insertion ...	18

Length of:

31.	anal fin from anterior insertion ...	16
32.	first gill opening ...	29
33.	second gill opening ...	32
34.	third gill opening ...	34
35.	fourth gill opening ...	25
36.	fifth gill opening ...	21
37.	Diameter of orbit ...	3
38.	Inter-orbital distance ...	71

As there was no buyer, on 18th evening the carcass was towed to the sea and discarded.

ON THE LANDING OF *RHINCODON TYPUS* SMITH ALONG ADIRAMPATINAM COAST, TANJORE DISTRICT, TAMIL NADU*

While operating bottom-set gill net *(Kalaivalai)* on 19–10–'85 at 8 m depth in Palk Strait off Adirampatinam, Shri Veerabadran, a boatman of Karayur, netted a whale shark and towed it the same day to the landing centre. The animal was alive until it reached the shore. It is reported that since last 30 years this is the first time such a huge whale shark has been caught in this area. The measurements taken (in cm) are as follows:

1.	Total length ...	900
2.	Height of body ...	210
3.	Girth of body ...	450
4.	Length of first fin (pectoral) ...	123
5.	Length of second fin (pectoral) ...	120
6.	Dorsal fin ...	115
7.	Second dorsal fin ...	85
8.	Length of caudal fin ...	198

*Reported by A. Ganapathy, Field Centre of CMFRI, Pattukottai.

ON A WHALE SHARK *RHINIODON TYPUS* SMITH LANDED AT CUFFE PARADE, BOMBAY*

A whale shark, *Rhiniodon typus* Smith measuring 5 m in total length was landed at Cuffe Parade landing centre at 15.30 hrs on 10th November, 1985. It was reported that the whale shark got entangled in a gill net operated by a mechanised boat about 15 km from the shore at about 30 m depth. The whale shark weighed approximately 5 tonnes and was sold for a price of Rs. 3,000/-.

*Reported by Shri M. Shriram, Bombay Research Centre of CMFRI, Bombay.

Compiled and prepared by Dr. M. J. George, Dr. K. J. Mathew, Shri. G. Nandakumar, Shri. I. David Raj, Miss Jancy Jacob & Shri. D. Vincent. Edited and published by Dr. M. J. George on behalf of the Director, Central Marine Fisheries Research Institute, Cochin-682 031. Printed at PAICO, Cochin-31

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CONTENTS

Front cover photo:

A view of the fisheries harbour at Cochin, the second major landing centre in Kerala for mechanised fishing vessels.

Back cover photo:

A view of the harboured boats at Sakthikulangara, the largest landing centre in Kerala for mechanised fishing boats.

MARINE FISH PRODUCTION IN INDIA — 1983-'84 AND 1984-'85*

ANNUAL PRODUCTION OF MARINE FISH — 1983–'84

The total estimated catch of exploited marine fishery resources during the year 1983–'84 along the coasts of India including the Union Territories of Andamans and Lakshadweep was 1.58 million tonnes as compared to 1.42 million tonnes in 1982–'83 showing an increase of about 12%.

Tables 1 (a) and 1 (b) show the exploited marine fishery resources of various species of fishes, prawns, lobsters and cephalopods along the Indian coasts during the years 1983–'84 and 1982–'83 considered separately as pelagic and demersal.

Table 1 (a) *(figures in tonnes)*

Sl. No.	Pelagic fishes	1983–'84	1982–'83
1	2	3	4
1.	Clupeids		
	a) Wolf herring	16,635	14,855
	b) Oil sardine	1,80,081	2,01,625
	c) Other sardines	76,841	59,407
	d) Hilsa shad	4,023	3,317
	e) Other shads	21,256	13,297
	f) Anchovies		
	Coilia	18,090	15,112
	Setipinna	3,382	1,784
	Stolephorus	89,802	40,673
	Thryssa	17,887	20,506
	g) Other clupeids	35,208	26,493
2.	Bombay duck	95,441	90,422
3.	Half beaks & Full beaks	2,603	2,628
4.	Flying fish	1,483	1,832
5.	Ribbon fishes	39,488	47,597
6.	Carangids		
	a) Horse mackerel	3,093	2;257
	b) Scads	9,160	9,061
	c) Leather-jackets	9,577	6,406
	d) Other carangids	29,099	27,288
7.	Mackerels		
	a) Indian mackerel	33,516	24,962
	b) Other mackerel	89	7
8.	Seer fishes		
	a) *S. commerson*	13,433	19,799
	b) *S. guttatus*	21,900	13,627
	c) *S. lineolatus*	286	176
	d) *Acanthocybium* spp.	201	9
9.	Tunnies		
	a) *E. affinis*	11,079	10,821
	b) *Auxis* spp.	2,596	1,953
	c) *K. pelamis*	2,651	2,139
	d) *T. tonggol*	11	11
	e) Other tunnies	2,692	4,491
10.	Bill fishes	758	2,114
11.	Barracudas	3,598	3,047
12.	Mullets	3,408	2,565
13.	Unicorn cod	452	64
14.	Miscellaneous	30,158	28,067
	TOTAL	7,79,977	6,98,412

* Prepared by Fishery Resources Assessment Division, C.M.F.R.I., Cochin.

Table 1 (b) *(figures in tonnes)*

Sl. No.	Demersal fishes	1983–'84	1982–'83
1	2	3	4
1.	Elasmobranchs		
	a) Sharks	39,019	39,367
	b) Skates	4,066	3,779
	c) Rays	27,802	21,956
2.	Eels	7,707	8,132
3.	Cat fishes	64,365	60,840
4.	Lizard fishes	15,613	12,982
5.	Perches		
	a) Rock cods	2,635	2,511
	b) Snappers	3,793	2,202
	c) Pig-face breams	2,201	2,686
	d) Threadfin breams	27,447	25,864
	e) Other perches	20,426	16,763
6.	Goat fishes	5,646	5,931
7.	Threadfins	7,412	6,574
8.	Croakers	1,08,572	82,170
9.	Silver bellies	87,772	70,122
10.	Big-jawed jumper	19,432	14,285

1	2	3	4
11.	Pomfrets		
	a) Black pomfret	16,524	12,878
	b) Silver pomfret	40,605	35,654
	c) Chinese pomfret	260	349
12.	Flat fishes		
	a) Halibut	1,718	1,384
	b) Flounders	289	97
	c) Soles	25,653	23,579
13.	Crustaceans		
	a) Penaeid prawns	1,16,619	1,17,467
	b) Non-penaeid prawns	50,633	56,094
	c) Lobsters	2,253	1,389
	d) Crabs	26,461	21,000
	e) Stomatopods	28,678	24,930
14.	Cephalopods	18,575	17,016
15.	Miscellaneous	31,058	28,806
	TOTAL	8,03,234	7,16,807
	Total of pelagic and demersal groups	15,83,211	14,15,219

Table-2 shows the total pelagic and demersal groups of exploited marine fishes and their percentages to the total catch during the years 1983–'84 and 1982–'83.

Table 2. *Marine fish landings in India (figures in tonnes)*

Groups	1983–'84	1982–'83
Pelagic	7,79,977 (49.3%)	6,98,412 (49.3%)
Demersal	8,03,234 (50.7%)	7,16,807 (50.7%)
TOTAL	15,83,211	14,15,219

From Table-2, it is seen that both pelagic and demersal groups maintain the same percentages to the total during the years 1983–'84 and 1982–'83. Consequently the increase in the catch of pelagic and demersal groups during the year 1983–'84 as compared to 1982–'83 is the same as that of the total exploited catch during 1983–'84 in relation to 1982–'83, the increase being 12%.

Pelagic fishes

1. *Oil sardine*

The estimate of the exploited resources of oil sardine along the Indian coast during 1983–'84 showed a minor decline of about 25,500 tonnes as compared to 1982–'83, the respective figures being 1.80 and 2.02 lakh tonnes. This was due to reduced landings in the coastal belt comprising Kerala, Karnataka, Goa and south Maharashtra, the catches in the belt for the two years respectively being 1.78 and 2.00 lakh tonnes. During 1983–'84, Kerala and Karnataka coasts contributed 83.15 and 13.28% of the total oil sardine landings in the belt, the shares of Goa and south Maharashtra being 2.00 and 0.49% respectively. Tamil Nadu and Pondicherry on the east coast of India also exploited oil sardine to the tune of 0.66 and 0.41 % of the total catch.

2. *Other sardines*

An increase of 29.35% was noticed in the catch of other sardines during 1983–'84 as compared to 1982–'83, the corresponding two figures being 0.77 and 0.59 lakh tonnes respectively. Unlike oil sardine, the other sardines are exploited by all the maritime states of India. Tamil Nadu, on the east coast of India, catches the maximum, its share in the all India landings being 44.74%. The other states which contribute substantially in the order of abundance are Andhra Pradesh (27.86%), Karnataka (9.05%), Orissa (6.36%), Kerala (6.09%) and Pondicherry (3.52%).

3. *Bombay duck*

During 1983–'84, the estimate of the exploited bombay duck resources along the Indian coast was about 0.95 lakh tonnes as compared to 0.90 lakh tonnes in 1982-'83, showing a minor increase of about 5,000 tonnes. The coastal belt of Maharashtra and Gujarat contributed the bulk of the catch, the individual share of the two maritime states being, 52.23% for Gujarat and 41.48% for Maharashtra. West Bengal, Orissa and Andhra Pradesh on the east coast of India also exploit Bombay duck on a limited scale.

4. *Stolephorus*

The catch of *Stolephorus* during the year 1983–'84 more than doubled as compared to 1982–'83, the two sets of estimates being 0.90 and 0.41 lakh tonnes respectively. Barring Gujarat and Lakshadweep coasts, *Stolephorus* was exploited along the rest of the Indian coast. An estimated 62.47% of the total *Stolephorus* catch was recorded in the coast of Kerala. The coasts of Karnataka (12.81%), Tamil Nadu (11.39%) and Andhra Pradesh (10.18%) were the other major regions where comparatively good catch was recorded.

5. *Ribbon fishes*

The catch of ribbon fishes in the year 1983–'84 showed a decline of about 8,100 tonnes (17.03%) as

compared to the last year, the corresponding estimated figures being 0.40 and 0.48 lakh tonnes respectively. The coasts of Maharashtra, Andhra Pradesh, Gujarat and Tamil Nadu recorded comparatively good catch, their individual share being 28.44, 21.55, 18.53 and 13.87% respectively.

6. *Mackerel*

An increase of about 34.27% in the exploited resource of mackerel was noticed during 1983–'84 as compared to 1982–'83, the estimated figures for the two years respectively being 0.34 and 0.25 lakh tonnes. The coastal belt comprising Kerala, Karnataka, Goa and South Maharashtra contributed about 0.16 lakh tonnes forming only 47.79%, whereas the remaining 52.21% of the catch was unusually recorded from the east coast of India including Andamans. Kerala coast accounted for 79.12% of the exploited landings of the west coast of India, the share of Karnataka being 15.43%.

Tamil Nadu contributed 45.77% of the exploited catch of the east coast of India, the share of the coasts of Andhra Pradesh, Orissa and Pondicherry in the order of abundance being 38.44, 9.17 and 4.65% respectively.

By and large, oil sardine, other sardines, Bombay duck, *Stolephorus,* ribbon fishes and mackerel together contributed to 66.06% of the total pelagic catch during 1983–'84, the share of which to the total exploited marine fish catch along the Indian coast being 49.30%.

Demersal fishes

Among demersal fishes, penaeid prawns formed the major catch (1.17 lakh tonnes) accounting for 14.52% of the total demersal catch of the Indian coasts during 1983–'84. Other important exploited fisheries in this category in the order of abundance were: croakers (1.09 lakh t, 13.52%), silver bellies (0.88 lakh t, 10.93%), elasmobranchs (0.71 lakh t, 8.82%), cat fishes (0.65 lakh t, 8.01%), pomfrets (0.57 lakh t, 7.15%) and perches (0.57 lakh t, 6.95%). All the fishes and prawns referred above constituted about 70% of the total demersal catch.

1. *Penaeid prawns*

The penaeid prawns are exploited by all the maritime states of India except Lakshadweep. Maharashtra contributed the maximum catch forming about 31.56% of the all India catch. The other maritime states which exploited this group on a comparatively large scale were Kerala (22.38%), Tamil Nadu(12.89%), Andhra Pradesh (10.38%), Gujarat (8.02%), Karnataka (5.96%) and Goa (5.09%).

2. *Croakers*

Barring Lakshadweep, the croakers are exploited along the entire coast of India. The maximum landings were recorded along the Gujarat coast constituting 28.34% of the total exploited catch of this resource along the Indian coasts. Maharashtra (17.01%), Orissa (15.27%), Tamil Nadu (11.94%), Andhra Pradesh (10.84%) and Kerala (6.84%) were the other maritime states which contributed substantially good landings.

3. *Silver bellies*

Tamil Nadu coast was responsible in the large scale exploitation of silver belly resource, its share in the total silver belly catch of the Indian coast during 1983–'84 being 69.36%. The landings from Kerala and Andhra coasts which came next in the order of abundance formed 10.46 and 7.82% respectively. The landings from the rest of the coast were poor.

4. *Elasmobranchs*

This group comprising sharks, skates and rays is exploited by all the maritime states of India. Tamil Nadu coast contributed the maximum catch, forming 26.03% of the total catch of elasmobranchs along the Indian coast. The other maritime states which substantially exploited this fishery were Maharashtra(18.63%), Gujarat (16.60%), Kerala (13.88%), and Andhra Pradesh (13.92%).

5. *Cat fishes*

Barring Lakshadweep, cat fishes are exploited along the entire Indian coasts. Kerala coast accounted for 25.05% of the total exploited resources of this fishery. Maharashtra (20.78%), Gujarat (16.42%), Karnataka (9.43%), Orissa (8.87%) and Tamil Nadu (8.28%) also substantially contributed to the catch of cat fishes along the coast line of India.

6. *Pomfrets*

Pomfret resource is exploited by all the maritime states of India except Lakshadweep. The major share of the total landings was from Maharashtra coast constituting about 41.29%. The other coasts which contributed comparatively good catches were Andhra Pradesh (17.95%), Gujarat (16.24%) and West Bengal (10.80%).

7. *Perches*

The entire coasts of India exploit perches throughout the year. Tamil Nadu accounted for 22.21% of the total catch of this fishery during 1983–'84. Kerala (20.93%), Andhra Pradesh (15.17%), Gujarat (13.83%) and Maharashtra (12.02%) were the other coasts where substantially good quantities of perches were landed. The landings in the rest of the coasts were comparatively poor.

Landings by mechanised and non-mechanised vessels

Estimated landings by mechanised and non-mechanised crafts are given below (figures in tonnes).

	1983–'84	1982–'83
Mechanised	9,17,654	8,90,365
Non-mechanised	6,65,557	5,24,854
TOTAL	15,83,211	14,15,219

Landings by mechanised crafts in 1983–'84 have recorded an increase of about 27,000 tonnes while the landings by non-mechanised crafts increased by 1,41,000 tonnes. Mechanised landings in 1983–'84 accounted for 58% of the total landings showing a reduction in the proportion compared to 63% in 1982–'83. However, the contribution from non-mechanised crafts in 1983–'84 accounted for 42% against 37% in 1982–'83.

Landings from different regions

Northeast coast: The total catch in the northeast coast region comprising West Bengal, Orissa, Andhra Pradesh and Andaman Nicobar Islands during 1983–'84 was estimated at 2,50,311 tonnes as compared to 1,86,222 tonnes in 1982–'83 showing an increase of about 64,000 tonnes. The landings of croakers, lesser sardines, pomfrets, *Stolephorus*, penaeid prawns, and non–penaeid prawns showed an increase of 17,300, 8,200, 7,600, 4,900, 4,800 and 4,400 tonnes respectively.

Southeast coast: The region consisting of Tamil Nadu and Pondicherry coasts recorded 2,92,128 tonnes during 1983–'84 as against 2,48,938 tonnes in 1982–'83 showing an increase of about 43,000 tonnes. While the catch of silver bellies, lesser sardines and elasmobranchs recorded higher landings by 16,300, 10,000 and 3,300 tonnes respectively, croakers and perches accounted lower landings by 3,600 and 1,400 tonnes respectively.

Southwest coast: The southwest coast region comprising Kerala, Lakshadweep, Karnataka and Goa registered 5,36,567 tonnes during 1983–'84 as compared to 5,16,095 tonnes during 1982-'83, recording an increase of about 20,472 tonnes. The catch of *Stolephorus* and croakers increased by 42,800 and 4,400 tonnes respectively. The landings of oil sardines and cat fishes, however, declined by 22,090 and 1,000 tonnes respectively.

Northwest coast: The total exploited catch in the northwest coast region showed an increase of about 34,200 tonnes in 1983-'84 as compared to 1982–'83, the respective figures being 4,98,167 and 4,63,964 tonnes. While the catch of croakers and pomfrets increased by 7,200 and 4,600 tonnes respectively, non-penaeid prawns showed a decline of about 9,500 tonnes.

ANNUAL PRODUCTION OF MARINE FISH — 1984–'85

Annual marine fish production in the country during the year 1984–'85 has been provisionally estimated at 1.62 million tonnes. Compared to the landings of 1.58 million tonnes in 1983–'84, the landings during the period under report has recorded a marginal increase of about 2%.

Among the commercially important varieties of fish, oil sardine accounted for 10.2% of the whole landings in 1984–'85 against 11.4% of 1983–'84. Penaeid prawns contributed 8.1% against 7.4% of previous year. Bombay duck accounted for 7.7% against 6.0% of previous year. 4.6% of landings was accounted for by non-penaeid prawns which was 3.2% in 1983–'84. *Stolephorous* spp. contributed 4.5% against 5.7% of previous year.

Pelagic and demersal groups of fishes

During 1984-'85 pelagic species contributed to about 8,14,000 tonnes accounting for 50.4% of the total landings while 49.6% came from demersal fishes including crustaceans. Table–3 shows the landings of pelagic and demersal fishes.

Table 3. *Marine fish landings in India (figures in tonnes)*

	1984–'85	1983–'84
Pelagic	8,14,464	7,79,977
Demersal	8,01,288	8,03,234
TOTAL	16,15,752	15,83,211

Pelagic fishes

The landings of pelagic species have increased by about 34,000 tonnes (4.4%) while the contribution from demersal species declined marginally by 2,000 tonnes.

Estimated landings of various pelagic species are provided in Table–4 (a).

Table 4 (a): *(figures in tonnes)*

Sl. No.	Pelagic fishes	1984–'85	1983–'84
1.	Clupeids		
	a) Wolf herring	18,424	16,635
	b) Oil sardine	1,65,537	1,80,081
	c) Other sardines	68,314	76,841
	d) Hilsa shad	9,609	4,023
	e) Other shads	14,962	21,256
	f) Anchovies		
	Coilia	24,272	18,090
	Setipinna	3,229	3,382
	Stolephorus	72,692	89,802
	Thryssa	20,180	17,887
	g) Other clupeids	43,024	55,208
2.	Bombay duck	1,24,947	95,441
3.	Half beaks & Full beaks	1,725	2,603
4.	Flying fish	2,699	1,483
5.	Ribbon fishes	52,318	39,488
6.	Carangids		
	a) Horse mackerel	4,316	3,093
	b) Scads	11,534	9,160
	c) Leather-jackets	13,515	9,577
	d) Other carangids	28,025	29,099
7.	Mackerels		
	a) Indian mackerel	40,411	33,516
	b) Other mackerel	104	89
8.	Seer fishes		
	a) *S. commerson*	17,548	13,433
	b) *S. guttatus*	16,218	21,900
	c) *S. lineolatus*	186	286
	d) *Acanthocybium* spp.	44	201
9.	Tunnies		
	a) *E. affinis*	11,389	11,079
	b) *Auxis* spp.	1,525	2,596
	c) *K. pelamis*	4,039	2,651
	d) *T. tonggol*	186	11
	e) Other tunnies	3,327	2,692
10.	Bill fishes	1,481	758
11.	Barracudas	3,907	3,598
12.	Mullets	4,310	3,408
13.	Unicorn cod	2,569	452
14.	Miscellaneous	27,898	30,158
	TOTAL	8,14,464	7,79,977

Among the major pelagic fishes, oil sardine contributed 1,66,000 tonnes accounting 20.3% of the whole pelagic fish landings. Bombay duck accounted for 15.4%; *Stolephorus* spp. 8.9%; other sardines 8.4%; carangids 7.0%; ribbon fishes 6.4% and mackerel 5.0%.

1. *Oil sardine*

About 98% of the whole landings of this species was accounted for by its landings in Kerala, Karnataka and Goa coasts. The landings of oil sardine showed a reduction by about 15,000 tonnes from its landings of 1,80,000 tonnes of 1983–'84. In Kerala, landings reduced by about 22,000 tonnes from a total of 1,50,000 tonnes of 1983–'84. But, in Karnataka the landings of oil sardine increased substantially by about 8,000 tonnes from a total of 24,000 tonnes of 1983–'84. Along the east coast, oil sardine landings have been recorded in Andhra Pradesh and Orissa coasts during the year 1984–'85 also, in addition to Tamil Nadu and Pondicherry.

2. *Bombay duck*

The landings of Bombay duck increased by 30,000 tonnes than in the previous year. Maharashtra and Gujarat together accounted for 97.4% of the landings of this fish in the country. In Maharashtra the landings of Bombay duck increased from about 40,000 tonnes of 1983–'84 to 61,000 tonnes showing an increase of about 54.7%. In Gujarat the landings increased to 60,000 tonnes in the reported year from 50,000 tonnes of the previous year (21.2%).

3. *Stolephorus*

Landings of *Stolephorus* spp. decreased by about 17,000 tonnes during the year 1984–'85 compared to the landings of previous year. From 90,000 tonnes of 1983–'84, the landings declined to 73,000 tonnes registering a reduction in the landings by about 19.0%. Kerala accounted for 56.9% of the total landings of *Stolephorus* spp. in the country. The landings from that state during the year under report, however, reduced by about 26.3% compared to previous year's figure of 56,000 tonnes. Tamil Nadu (including Pondicherry) accounted for 20.8% of the landings of this species where its landings increased by 4,500 tonnes compared to the previous year. The landings at Karnataka accounted for 16.1% where the landings increased by about 200 tonnes from 11,500 tonnes of previous year. *Stolephorus* spp. is caught along the entire coast line except in Gujarat and Lakshadweep.

4. *Ribbon fishes*

Landings of ribbon fishes increased by 13,000 tonnes from the previous year's landings of 39,000 tonnes. 23.4% of the landings of this fish was accounted by the Tamil Nadu coast where the landings in the year under report increased to 6,600 tonnes from 5,600 tonnes of 1983–'84. Maharashtra contributed 20% of the landings where they decreased marginally by 6.8% from 11,200 tonnes of 1983–'84 to 10,500 tonnes. Considerable landings of this fish were recorded in Gujarat (9,100 tonnes, 17.5%), Kerala (6,600 tonnes, 12.5%) and Andhra Pradesh (600 tonnes, 11.4%). In Gujarat the landings increased by about 24.8% and in Kerala the landings increased considerably compared to 1,100 tonnes of the previous year. However, in Andhra Pradesh, a decrease by 29.7% was observed in their landings.

5. *Mackerel*

The landings of mackerel (40,000 tonnes) showed an increase of about 6,900 tonnes in 1984–'85 compared to the landings of 33,500 tonnes of 1983-'84. Kerala contributed 32.0% of total mackerel landings, the level of landings in that state remaining the same as that of previous year with a marginal increase of 1.8%. In Karnataka the landings (12,800 tonnes, 31.6%) showed an increase of about 10,300 tonnes from 2,500 tonnes of 1983–'84. Tamil Nadu coast accounted for 12.1% of the total mackerel landings where the landings declined by 3,100 tonnes compared to previous year's landings. Andhra Pradesh accounted for 11.1% of the landings of this fish where it registered a decline in the landings by about 2,200 tonnes. Landings of mackerel in Goa increased by 2,500 tonnes and accounted for 6.7% of the landings of mackerel in the country.

Demersal group

Estimated landings of various demersal species of fish and crustaceans are given in Table–4 (b).

Among the demersal species, penaeid prawns accounted for 16.3% of the total landings of this group. Croakars contributed 13.6% followed by non-penaeid prawns (9.2%), elasmobranchs (6.9%), silver bellies (6.5%), cat fishes (6.5%) and pomfrets (5.8%).

1. *Panaeid prawns*

The landings of penaeid prawns in 1984–'85 recorded an increase of 14,000 tonnes. The landings increased from 1,17,000 tonnes in 1983–'84 to 1,31,000 tonnes in 1984–'85 showing an increase of about 11.9%. The landings in Maharashtra (45,000 tonnes) accounted for 34.8% of the total penaeid prawn landings in the country. Other regions which contributed considerably to the landings of penaeid prawns were Kerala (37,000 tonnes, 28.5%), Gujarat (14,000 tonnes, 10.6%), Tamil Nadu (13,000 tonnes, 9.6%), Andhra Pradesh (8,000 tonnes, 5.9%) and Karnataka (6,000 tonnes, 4.2%).

In Maharashtra the landings of penaeid prawns increased by about 7,000 tonnes from 37,000 tonnes of

Table 4 (b). *(figures in tonnes)*

Sl. No.	Demersal fishes	1984–'85	1983–'84
1.	Elasmobranchs		
	a) Sharks	34,215	39,019
	b) Skates	2,729	4,066
	c) Rays	18,061	27,802
2.	Eels	7,962	7,707
3.	Cat fishes	52,290	64,365
4.	Lizard fishes	14,864	15,613
5.	Perches		
	a) Rock cods	3,154	2,635
	b) Snappers	4,551	3,793
	c) Pig-face breams	1,769	2,201
	d) Threadfin breams	38,316	27,447
	e) Other perches	24,404	20,426
6.	Goat fishes	4,540	5,646
7.	Thread fins	8,510	7,412
8.	Croakers	1,08,672	1,08,572
9.	Silver bellies	52,157	87,772
10.	Big-jawed jumper	18,656	19,432
11.	Pomfrets		
	a) Black pomfret	11,494	16,524
	b) Silver pomfret	34,639	40,605
	c) Chinese pomfret	446	260
12.	Flat fishes		
	a) Halibut	1,733	1,718
	b) Flounders	75	289
	c) Soles	42,651	25,653
13.	Crustaceans		
	a) Penaeid prawns	1,30,540	1,16,619
	b) Non-penaeid prawns	73,964	50,633
	c) Lobsters	3,250	2,253
	d) Crabs	26,488	26,461
	e) Stomatopods	29,616	28,678
14.	Cephalopods	24,096	18,575
15.	Miscellaneous	27,446	31,058
	TOTAL	8,01,288	8,03,234

1983–'84. In Kerala the landings increased by 11,000 tonnes from 26,000 tonnes of 1983–'84. In Gujarat also the landings of penaeid prawns registered an increase by about 4,000 tonnes from 9,000 tonnes of 1983–'84. However, the landings in Andhra Pradesh decreased by about 4,000 tonnes. Similarly the landings in Tamil Nadu decreased by 2,000 tonnes and in Karnataka also a decrease of about 1,000 tonnes was observed. In Goa the landings of penaeid prawns decreased by 2,000 tonnes from about 6,000 tonnes of 1983–'84.

2. *Croakers*

The landings of croakers in the country during the year under report remained more or less at the same level as that of previous year, the landings being 1,09,000 tonnes. The landings in Gujarat which accounted for 33.5% of the whole landings of croakers in the country registered an increase of about 18.4% in the year under report and quantitatively the increase was from 31,000 tonnes of 1983–'84 to 36,000 tonnes in the year 1984–'85. Maharashtra accounted for 18.6% of the landings where a marginal increase was observed in the landings from about 18,000 tonnes of 1983–'84 to about 20,000 tonnes in 1984–'85. In Orissa the landings registered an increase of about 2,000 tonnes compared to previous year. The landings in Orissa of about 18,000 tonnes, accounted for 17% of the whole landings of this fish in the country. Other regions which contributed considerably were Tamil Nadu (10,000 tonnes, 9.2%), Kerala (9,800 tonnes, 9.0%) and Andhra Pradesh (7,700 tonnes, 7.0%). In Kerala the landings increased by about 2,400 tonnes as compared to the landings of previous year. The landings decreased by about 4,100 tonnes in Andhra Pradesh and by 2,300 tonnes in Tamil Nadu.

3. *Non-penaeid prawns*

The landings of this group increased from 51,000 tonnes in 1983–'84 to 74,000 tonnes in 1984–'85 showing an increase of about 23,000 tonnes. Maharashtra and Gujarat together accounted for 84.5% of the total landings in the country. The landings in Maharashtra increased by about 19,000 tonnes in the year under report from 33,000 tonnes of the previous year. Similarly the landings showed an increase of about 3,000 tonnes in Gujarat from about 8,000 tonnes of 1983–'84. In the east coast, non-penaeid prawns were recorded in substantial quantities in West Bengal and Andhra Pradesh. The landings in West Bengal increased by about 4,000 tonnes in 1984–'85, from about 4,000 tonnes of 1983–'84. However, the landings showed considerable decrease in Andhra Pradesh where it declined from about 6,000 tonnes in 1983–'84 to the order of 1,000 tonnes in 1984–'85.

4. *Silver bellies*

A steep decline of about 36,000 tonnes was observed in the landings of silver bellies in the year 1984–'85. From 88,000 tonnes of 1983–'84 the landings decreased to 52,000 tonnes in 1984–'85. Tamil Nadu coast which accounted for 68.7% of the landings of silver bellies suffered a reduction in its landings by about 26,000 tonnes from 63,000 tonnes of 1983–'84. Andhra Pradesh which accounted for 8.9% of the landings of silver bellies, suffered a decrease of about 2,000 tonnes from about 7,000 tonnes of 1983–'84. Kerala which accounted for 7.3% of the landings sustained a decrease of about 5,000 tonnes from 9,000 tonnes of 1983–'84. In Karnataka landings of silver bellies showed a reduction of about 2,000 tonnes from about 5,000 tonnes of 1983–'84.

5. *Perches*

The landings of perches in the year 1984–'85 showed an overall increase of about 16,000 tonnes over about 57,000 tonnes of previous year. Threadfin breams constituting 53.1% of the perches increased by about 11,000 tonnes from previous year's landings of 27,000 tonnes. Major contribution for the landings of perches came from Kerala (about 29,000 tonnes) accounting for 39.8% of the whole landings in the country, followed by Tamil Nadu (11,600 tonnes, 16.0%), Andhra Pradesh (11,500 tonnes, 15.9%), Gujarat (9,500 tonnes, 13.2%) and Maharashtra (5,200 tonnes, 7.1%).

6. *Elasmobranchs*

A decrease of about 16,000 tonnes was observed in the landings of elasmobranchs, the landings in 1983–'84 and 1984–'85 being about 71,000 tonnes and 55,000 tonnes respectively. Gujarat accounted for 21.7% of the total elasmobranch landings in the country. In 1984–'85, landings in Gujarat remained at the same level of 1983–'84; the landings being about 12,000 tonnes. Tamil Nadu which accounted for 20.2% of the country's landings suffered a decline of about 39.3% in the landings from about 19,000 tonnes of 1983–'84, to about 11,000 tonnes in 1984–'85. In Andhra Pradesh the landings in both the years remained at about 10,000 tonnes which accounted for about 19.1% of the landings of elasmobranchs in the country. Kerala which accounted for 11.8% of the landings suffered a decline of about 3,300 tonnes from 9,800 tonnes in 1983–'84 to 6,500 tonnes in 1984–'85.

7. *Cat fishes*

The landings of cat fishes decreased from 64,000 tonnes of 1983–'84 to 52,000 tonnes of 1984–'85. Maharashtra which accounted for 21.2% of the landings in the country suffered a decline of about 2,000 tonnes, from about 13,000 tonnes of 1983–'84 to 11,000 tonnes of 1984–'85. Kerala, which accounted for 20.1% of the landings sustained a reduction in the landings by about 6,000 tonnes from 16,000 tonnes of 1983–'84 to about 10,000 tonnes of 1984–'85. Similarly the landings in Gujarat which accounted for 18.4% showed a decline of about 1,000 tonnes from 11,000 tonnes of 1983–'84. Other regions which contributed substantially to the landings of cat fishes were Orissa (6,000 tonnes, 11.3%), Andhra Pradesh (5,500 tonnes, 10.5%), Tamil Nadu (about 3,000 tonnes, 5.7%) and Karnataka (about 3,000 tonnes, 5.6%). The landings decreased by about 2,000 tonnes in Tamil Nadu and by 3,000 tonnes in Karnataka compared to previous year's landings, while in Andhra Pradesh the landings increased by about 2,000 tonnes.

8. *Pomfrets*

The landings of pomfrets decreased from about 57,000 tonnes of 1983–'84 to 46,000 tonnes of 1984–'85 showing a reduction of about 11,000 tonnes. Maharashtra which accounted for 37.9% of the landings suffered a decline of about 6,000 tonnes where the landings of 24,000 tonnes in 1983–'84 reduced to 18,000 tonnes of 1984–'85. But Gujarat which accounted for 31.6% of the landings registered an increase in its landings by over 5,000 tonnes, the landings in 1984–'85 being about 15,000 tonnes. In east coast, Andhra Pradesh which accounted for 10.9% of the landings suffered a decline of 5,000 tonnes from 10,000 tonnes in 1983–'84 to 5,000 tonnes in 1984–'85. The landings in West Bengal also showed a considerable decline of about 4,000 tonnes where the landings declined from 6,000 tonnes of 1983–'84 to about 2,000 tonnes of 1984–'85.

Landings by mechanised/non-mechanised crafts

Table–5 gives the landings by mechanised and non-mechanised vessels in 1984–'85 compared to the corresponding landings during 1983–'84.

Landings by mechanised vessels have shown considerable increase in 1984–'85 over that of 1983–'84, the increase being 2,32,000 tonnes (25.3%). The landings by non-mechanised vessels however, suffered a decrease of about 1,99,000 tonnes (30.0%). The mechanised landings accounted for 70.9% of the total landings

Table 5. *(figures in tonnes)*

Category of crafts	1984–'85	1983–'84
Mechanised	11,49,694	9,17,654
Non-mechanised	4,66,058	6,65,557
TOTAL	16,15,752	15,83,211

in 1984–'85, while the same was only 58% in 1983–'84. The contribution from non-mechanised vessels which was 42% in 1983–'84 has reduced to 29.10% in 1984–'85.

Landings in different regions

Northeast coast: Northeast region comprising of West Bengal, Orissa, Andhra Pradesh and Andaman & Nicobar islands contributed 14% of the landings in the country in 1984–'85. The landings of 2,25,000 tonnes during 1984–'85 showed a decline of about 32,000 tonnes from the landings of previous year in this region. Among the commercially important varieties, penaeid prawns and croakers registered reduction in the landings by 4,400 tonnes each and Bombay duck by 2,700 tonnes.

Southeast coast: Southeast region comprising of Tamil Nadu coast (including Pondicherry) accounted for 15% of the landings in the country as a whole. This region also registered a decline in the annual landings by about 45,000 tonnes from 2,92,000 tonnes of previous year. Among the commercially important varieties, silver bellies declined by 26,000 tonnes from the previous year's landings of 63,000 tonnes. Similarly landings of other sardines reduced by about 9,000 tonnes from 37,000 tonnes of 1983–'84. However, *Stolephorus* spp. showed an increase in the landings by 4,500 tonnes.

Southwest coast: Southwest region comprising of Kerala, Karnataka, Goa and Lakshadweep contributed 34% of the marine fish landings in the country which showed a marginal increase of about 7,000 tonnes in 1984–'85 over the landings of 5,37,000 tonnes of the previous year. Among the important species in this region, oil sardine showed a reduction in the landings by 15,000 tonnes from 1,77,000 tonnes of previous year. Similarly *Stolephorus* spp. also reduced in its landings by about 15,000 tonnes. However, perches registered an increase in the landings by about 16,000 tonnes, mackerel by 13,000 tonnes and penaeid prawns by 8,000 tonnes.

Northwest coast: Northwest region comprising of Maharashtra and Gujarat accounted for 37% of the landings in the country. Landings in this region during 1984–'85 registered a substantial increase by about 1,01,000 tonnes over the previous year's landings of 4,98,000 tonnes. Among the major species that accounted for this steep increase were Bombay duck which increased by 32,000 tonnes, penaeid prawns which increased by 13,000 tonnes and non-penaeid prawns which increased by 22,000 tonnes. However, elasmobranchs reduced in its landings by 3,000 tonnes.

Landings by mechanised and non-mechanised crafts in states

Tables 6 (a to j) give the landings by mechanised and non-mechanised crafts in the maritime states during the years 1983-'84 and 1984-'85. Salient features of the landings by mechanised and non-mechanised crafts during this period are given below.

West Bengal

The landings by mechanised crafts in West Bengal during 1983–'84 were about 13,200 tonnes showing an increase of about 1,900 tonnes (16%) from the landings of about 11,400 tonnes of 1982–'83. Pomfrets formed the major catch in the mechanised landings with 41% followed by Bombay duck (18%). Landings by non-mechanised boats showed an increase of about 7,600 tonnes from the previous year's landings of about 11,100 tonnes. In this, non-penaeid prawns formed the major catch with 23% followed by croakers (13%) and Bombay duck (12%).

The landings by mechanised crafts during 1984–'85 was estimated at about 20,600 tonnes showing an increase of about 7,300 tonnes (56%) over the landings in the previous year. Pomfrets formed the major component of landings by mechanised boats but its share reduced considerably to 10% from the previous year's 41%. The landings by non-mechanised units showed a reduction in 1984–'85 by about 6,400 tonnes (34%) than during 1983-'84. Non-penaeid prawns which formed the major component of the landings by the non-mechanised boats accounted for about 64%. In quantity, this was 3,000 tonnes more than that in 1983–'84.

Orissa

The landings by mechanised crafts in 1983–'84 accounted for about 59% of the total marine fish landings in the state against 35% of the previous year and showed an increase of about 17,400 tonnes in 1983–'84 over 11,900 tonnes of 1982–'83. Croakers which accounted for 53% formed the major component of the landings by the mechanised boats. The landings of croakers by mechanised crafts showed an increase of about 12,900 tonnes over about 2,700 tonnes of previous year. The landings by trawlers formed the major component accounting for about 86% of the mechanised landings. The landings by non-mechanised crafts showed a reduction by about 1,400 tonnes (7%) from the previous year's landings of about 21,600 tonnes. Among the commercially important varieties, mackerel with 8% formed the major component of the landings by the non-mechanised crafts followed by pomfrets (6%) and croakers (5%).

In 1984–'85, the landings by mechanised crafts accounted for 63% of the total marine fish landings in the state against 59% of the year 1983–'84. Mechanised landings in 1984–'85 showed an increase of about 3,100 tonnes (11%). Among the commercially important varieties, croakers with 53% formed the major component of landings by mechanised crafts showing an increase of about 1,700 tonnes (11%) over the previous year's landings of about 15,500 tonnes. 96% of the landings by mechanised crafts in the state was by the trawlers. The landings of croakers by trawlers accounted for about 93% of the landings of this fish in the state and it formed the major component (55%) in the landings by trawlers.

Andhra Pradesh

Landings by mechanised crafts in Andhra Pradesh during 1983–'84 were estimated at about 47,800 tonnes accounting for 29% of the total marine fish landings in the state registering an increase of about 13,600 tonnes (40%) over the corresponding landings of 1982-'83. Among the commercially important varieties, penaeid prawns with 16% formed the major component followed by croakers (15%) and perches (13%). The landings by non-mechanised units in 1983–'84 showed an increase of about 25,100 tonnes (27%) over the corresponding landings of previous year. Among the commercially important varieties, pomfrets with 9% formed the major component of landings by the non-mechanised vessels, followed by mackerel (5%), croakers (4%) and penaeid prawns (4%).

The landings by mechanised crafts in 1984–'85 was estimated at about 31,100 tonnes accounting for 23% of the total marine fish landings in the state and showed a reduction of about 16,800 tonnes from the previous

Table 6 (a). *Estimated marine fish landings by mechanised and non-mechanised fishing crafts in West Bengal during* 1982–'83, 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Name of fish	1982–'83				
	Mechanised			Non-Mech.	Grand Total
	Power propulsion				
	Drift/ Gillnet	Others	Total	Total	
Oil sardine	—	—	—	—	—
Mackerel	—	—	—	2	2
Bombay duck	10	328	338	1,162	1,500
Croakers	46	364	410	775	1,185
Perches	—	—	—	51	51
Pomfrets	1,460	1,324	2,784	1,882	4,666
Tunnies	—	—	—	—	—
Penaeid prawns	—	20	20	268	288
Non-penaeid prawns	—	214	214	468	682
Others	2,122	5,467	7,589	6,481	14,070
TOTAL	3,638	7,717	11,355	11,089	22,444
No. of operations of units	25,837	15,288	41,125	1,48,419	

Name of fish	1983–'84							
	Mechanised						Non-Mech.	Grand Total
	Mech. fishing		Power propulsion					
	Trawl net	Gill net	Bag net	Hooks & lines	Others	Total	Total	
Oil sardine	—	—	—	—	—	—	—	—
Mackerel	—	6	—	—	—	6	—	6
Bombay duck	—	1,357	1,026	—	—	2,383	2,262	4,645
Croakers	7	107	277	5	85	481	2,332	2,813
Perches	—	26	—	—	—	26	16	42
Pomfrets	—	5,296	59	—	—	5,355	383	5,738
Tunnies	—	—	—	—	—	—	—	—
Penaeid prawns	—	32	92	—	—	124	1,538	1,662
Non-penaeid prawns	—	—	102	—	—	102	4,289	4,391
Others	23	4,097	397	215	—	4,732	7,834	12,566
TOTAL	30	10,921	1,953	220	85	13,209	18,634	31,863
No. of operations of units		60,149	6,041	1,822	26	68,038	1,36,552	

Name of fish	1984–'85						
	Mechanised					Non-mech.	Grand Total
	Mech. fishing		Power propulsion				
	Trawl net	Gill net	Bag net	Hooks & lines	Total	Total	
Oil sardine	—	—	—	—	—	—	—
Mackerel	—	36	—	—	36	1	37
Bombay duck	—	31	896	—	927	1,121	2,048
Croakers	2	507	449	—	958	535	1,493
Perches	—	51	1	3	55	40	95
Pomfrets	—	2,102	12	—	2,114	86	2,200
Tunnies	—	29	—	—	29	2	31
Penaeid prawns	—	—	949	—	949	85	1,034
Non-penaeid prawns	—	—	73	—	73	7,916	7,989
Others	5	9,963	5,239	202	15,409	2,518	17,927
TOTAL	7	12,719	7,619	205	20,550	12,304	32,854
No. of operations of units		39,265	9,767	2,350	51,382	74,071	

Table 6 (b). *Estimated marine fish landings by mechanised and non-mechanised fishing crafts in Orissa during* 1982–'83, 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Name of fish	1982–'83				
	Mechanised			Non-Mech.	Grand Total
	Mech. fishing	Power propulsion			
	Trawl net	Drift/ Gill net	Total	Total	
Oil sardine	—	—	—	—	—
Mackerel	2	—	2	972	974
Bombay duck	10	—	10	169	179
Croakers	2,663	21	2,684	1,319	4,003
Perches	—	—	—	1,662	1,662
Pomfrets	162	155	317	2,362	2,679
Tunnies	—	—	—	305	305
Penaeid prawns	1,606	—	1,606	425	2,031
Non-penaeid prawns	225	—	225	1	226
Others	6,752	253	7,005	14,426	21,431
TOTAL	11,420	429	11,849	21,641	33,490
No. of operations of units	70,234	11,947	7,86,391		

Name of fish	1983–'84				
	Mechanised			Non-Mech.	Grand Total
	Mech. fishing	Power propulsion			
	Trawl net	Gill net	Total	Total	
Oil sardine	—	—	—	—	—
Mackerel	3	—	3	1,602	1,605
Bombay duck	247	—	247	57	304
Croakers	15,399	150	15,549	1,029	16,578
Perches	769	—	769	198	967
Pomfrets	248	1,458	1,706	1,298	3,004
Tunnies	—	—	—	16	16
Penaeid prawns	1,556	—	1,556	384	1,940
Non-penaeid prawns	15	—	15	—	15
Others	6,886	2,508	9,394	15,612	25,006
TOTAL	25,123	4,116	29,239	20,196	49,435
No. of operations of units	68,606	66,843		6,85,420	

Name of fish	1984–'85				
	Mechanised			Non-Mech.	Grand Total
	Mech. fishing	Power propulsion			
	Trawl net	Gill net	Total	Total	
Oil sardine	—	—	—	539	539
Mackerel	—	—	—	349	349
Bombay duck	263	—	263	40	303
Croakers	17,167	112	17,279	1,159	18,438
Perches	476	—	476	211	687
Pomfrets	557	549	1,106	1,024	2,130
Tunnies	—	—	—	88	88
Penaeid prawns	2,147	—	2,147	372	2,519
Non-penaeid prawns	—	—	—	—	—
Others	10,539	535	11,074	15,021	26,095
TOTAL	31,149	1,196	32,345	18,803	51,148
No. of operations of units	95,400	16,069		7,63,692	

able 6 (c). *Estimated marine fish landings from mechanised and non-mechanised fishing crafts in Andhra Pradesh during 1982–'83, 1983–'84 and 1984–'85 (figures in tonnes)*

ame of fish	1982–'83					1983–'84						1984–'85					
	Mechanised			Non-mech.	Grand Total	Mechanised				Non-mech.	Grand Total	Mechanised				Non-mech.	Grand Total
	Mech. fishing					Mech. fishing		Power propulsion				Mech. fishing		Power propulsion			
	Purse seine	Trawl net	Total	Total		Purse-seine	Trawl net	Drift/ Gillnet	Total	Total		Purse-seine	Trawl net	Gill net	Total	Total	
il sardine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	164	164
lackerel	—	205	205	3,977	4,182	—	368	—	368	6,358	6,726	—	113	—	113	4,384	4,497
ombay duck	—	581	581	882	1,463	—	264	—	264	757	1,021	—	163	—	163	749	912
roakers	—	4,311	4,311	4,319	8,630	1	7,154	1	7,156	4,612	11,768	—	3,915	—	3,915	3,744	7,659
erches	—	4,442	4,442	3,187	7,629	—	6,386	5	6,391	2,178	8,569	—	3,678	12	3,690	7,803	11,493
omfrets	—	184	184	3,604	3,788	4	101	1	106	10,194	10,300	—	164	—	164	4,915	5,079
unnies	—	—	—	941	941	10	—	—	10	811	821	—	8	1	9	987	996
enaeid prawns	—	5,598	5,598	3,108	8,706	—	7,519	—	7,519	4,587	12,106	—	5,105	—	5,105	2,542	7,647
on-penaeid prawns	—	1,202	1,202	3,669	4,871	—	2,564	—	2,564	3,003	5,567	—	711	—	711	529	1,240
thers	6	17,784	17,790	68,004	85,794	9	23,437	55	23,501	84,321	1,07,822	5	17,216	33	17,254	75,924	93,178
TOTAL	6	34,307	34,313	91,691	1,26,004	24	47,793	62	47,879	1,16,821	1,64,700	5	31,073	46	31,124	1,01,741	1,32,865
No. of operations of units		1,10,879		25,99,163			1,31,874	284		25,01,548			1,11,230	233		22,48,979	

Table 6 (d). *Estimated marine fish landings by mechanised and non-mechanised fishing crafts in Tamil Nadu during the years 1982–'83, 1983–'84 and 1984–'85 (figures in tonnes)*

Name of fish	1982–'83						1983–'84								1984–'85						
	Mechanised				Non-mech.	Grand Total	Mechanised						Non-mech.	Grand Total	Mechanised					Non-mech.	Grand Total
	Mech. fishing	Power propulsion					Mech. fishing		Power propulsion						Mech. fishing	Power propulsion					
	Trawl net	Drift/ Gillnet	Hooks & lines	Total	Total		Trawl net	Purse-seine	Drift net	Gill net	Hooks & lines	Total	Total		Trawl net	Gill net	Drift net	Hooks & lines	Total	Total	
Oil sardine	—	—	—	—	1,094	1,094	66	—	—	—	—	66	1,130	1,196	8	—	—	—	8	1,331	1,3
Mackerel	59	39	—	98	3,646	3,744	869	—	—	2	—	871	7,138	8,009	87	53	—	39	179	4,712	4,8
Bombay duck	—	—	—	—	8	8	—	—	—	—	—	—	—	—	—	—	—	—	—	4	
Croakers	14,028	—	—	14,028	2,594	16,622	10,155	—	—	7	—	10,162	2,799	12,961	5,797	17	—	—	5,814	4,173	9,9
Perches	5,060	22	284	5,366	8,322	13,688	5,530	—	—	28	—	5,558	6,990	12,548	4,630	72	—	155	4,857	5,880	10,7
Pomfrets	297	15	—	312	862	1,174	227	—	10	7	—	244	912	1,156	269	48	16	—	333	708	1,0
Tunnies	1	1,583	6	1,590	1,883	3,473	36	3	245	313	5	602	1,899	2,501	222	100	580	25	927	785	1,7
Penaeid prawns	11,415	—	—	11,415	1,634	13,049	12,610	—	—	—	—	12,610	2,419	15,029	10,292	—	—	—	10,292	2,275	12,5
Non-penaeid prawns	151	—	—	151	259	410	85	—	—	—	—	85	61	146	133	—	—	—	133	1,315	1,4
Others	84,273	2,504	541	87,318	95,373	1,82,691	1,10,735	5	450	908	267	1,12,365	1,11,123	2,23,488	74,661	1,412	3,006	270	79,349	1,09,523	1,88,8
TOTAL	1,15,284	4,163	831	1,20,278	1,15,675	2,35,953	1,40,313	8	705	1,265	272	1,42,563	1,34,471	2,77,034	96,099	1,702	3,602	489	1,01,892	1,30,706	2,32,5
No. of operations of units	4,97,137	18,058	3,150		38,78,326		5,26,404		7,159	8,141	807		45,43,220		4,29,337	21,511	17,007	7,711		38,47,048	

able 6 (e). *Estimated marine fish landings by mechanised and non-mechanised fishing crafts in Pondicherry during the years* 1982–'83, 1983–'84 *and* 1984–'85 *(figures in tonnes)*

ame of fish	1982–'83 Mechanised Mech. fishing Trawl net	1982–'83 Mechanised Power propulsion Drift/ Gill net	1982–'83 Power propulsion Hooks & lines	1982–'83 Total	1982–'83 Non-mech. Total	1982–'83 Grand Total	1983–'84 Mechanised Mech. fishing Trawl net	1983–'84 Power propulsion Gill net	1983–'84 Total	1983–'84 Non-mech. Total	1983–'84 Grand Total	1984–'85 Mechanised Mech. fishing Trawl net	1984–'85 Power propulsion Gill net	1984–'85 Power propulsion Hooks & lines	1984–'85 Total	1984–'85 Non-mech. Total	1984–'85 Grand Total
il sardine	—	—	—	—	—	—	—	—	—	736	736	—	—	—	—	358	358
lackerel	5	—	—	5	733	738	1	—	1	812	813	1	—	—	1	919	920
ombay duck	—	—	—	—	2	2	—	—	—	—	—	—	—	—	—	—	—
roakers	407	—	—	407	152	559	240	—	240	404	644	206	—	—	206	484	690
erches	1,227	1	—	1,228	260	1,488	880	10	890	319	1,209	645	—	—	645	200	845
omfrets	—	—	—	—	114	114	1	5	6	97	103	2	—	—	2	164	166
unnies	—	54	—	54	—	54	9	96	105	—	105	—	90	—	90	11	101
enaeid prawns	230	—	—	230	35	265	459	—	459	162	621	427	—	—	427	284	711
on-penaeid prawns	—	—	—	—	9	9	5	—	5	6	11	56	—	—	66	6	52
thers	2,158	487	3	2,648	7,108	9,756	3,592	256	3,848	7,004	10,852	2,520	368	1	2,889	8,198	11,087
TOTAL	4,027	542	3	4,572	8,413	12,985	5,187	367	5,554	9,540	15,094	3,857	458	1	4,316	10,624	14,940
o. of operations units	33,285	2,636	120		2,60,833		35,949	2,830		3,50,368		29,301	4,892	25		369,646	

able 6 (f). *Estimated landings of marine fish from mechanised and non-mechanised fishing crafts in Kerala during* 1982–'83, 1983–'84 *and* 1984–'85 *(figures in tonnes)*

ame of h	1982–'83 Mechanised Mech. fishing Trawl net	1982–'83 Mech. fishing Purse-seine	1982–'83 Power propulsion Drift/ Gillnet	1982–'83 Power propulsion Others	1982–'83 Total	1982–'83 Non-mech. Total	1982–'83 Grand Total	1983–'84 Mechanised Mech. fishing Trawl net	1983–'84 Mech. fishing Purse-seine	1983–'84 Power propulsion Drift/ Gillnet	1983–'84 Power propulsion Others	1983–'84 Total	1983–'84 Non-mech. Total	1983–'84 Grand Total	1984–'85 Mechanised Mech. fishing Trawl net	1984–'85 Mech. fishing Purse-seine	1984–'85 Power propulsion Drift/ Gillnet	1984–'85 Power propulsion Others	1984–'85 Total	1984–'85 Non-mech. Total	1984–'85 Grand Total
l sardine	1,200	6,401	2	73,379	80,982	78,506	1,59,488	2,413	11,617	15	19,940	33,985	1,15,755	1,49,740	304	12,045	3	87,016	99,368	28,871	1,28,239
ack-erel	10	1,949	154	1,982	4,095	5,175	9,270	32	1,328	298	100	1,758	10,950	12,708	26	2,035	715	3,639	6,415	6,522	12,937
mbay duck	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
oa-kers	2,550	2	32	80	2,664	1,187	3,851	4,439	11	78	155	4,683	2,748	7,431	6,236	28	49	787	7,100	2,699	9,799
rches	9,151	6	26	70	9,253	1,527	10,780	8,934	1	105	458	9,498	2,328	11,826	23,631	1	65	2,853	26,550	2,163	28,713
m-frets	134	206	1,165	34	1,539	2,842	4,381	202	170	1,022	6	1,400	371	1,771	74	89	704	418	1,285	323	1,608
nnies	1	43	1,327	174	1,545	4,760	6,305	—	1	2,168	57	2,226	3,708	5,934	2	13	2,005	1,646	3,666	2,462	6,128
naeid prawns	26,507	290	—	606	27,403	4,885	32,288	19,496	45	—	26	19,567	6,533	26,100	25,931	28	—	9,055	35,014	2,154	37,168
n-penaeid prawns	—	—	—	—	—	33	33	—	—	—	—	—	170	170	—	—	—	—	—	719	719
hers	31,960	661	7,867	11,267	51,755	70,292	1,22,047	34,572	1,053	13,033	2,719	51,377	1,15,997	1,67,374	41,606	2,669	9,868	39,132	93,275	58,889	1,52,164
TAL	71,513	9,558	10,573	87,592	1,79,236	1,69,207	3,48,443	70,088	14,226	16,719	23,461	1,24,494	2,58,560	3,83,054	97,810	16,908	13,409	1,44,546	2,72,673	1,04,802	3,77,47[illegible]
. of operations of ts	3,63,556	8,123	76,779	2,08,497		22,79,293		3,77,388	7,000	85,037	1,29,406	5,98,831	25,03,492		3,22,967	6,140	84,993	6,05,166	10,19,266	18,08,141	

e 6 (g). *Estimated marine fish landings from mechanised and non–mechanised fishing crafts in Karnataka during 1982–'83, 1983–'84 and 1984–'85 (figures in tonnes)*

ne of fish	1982–'83							1983–'84							1984–'85						
	Mechanised					Non-mech.	Grand Total	Mechanised					Non-mech.	Grand Total	Mechanised					Non-mech.	Grand Total
	Mechanised fishing		Power propulsion					Mechanised fishing		Power propulsion					Mechanised fishing		Power propulsion				
	Trawl net	Purse-seine	Drift/ Gillnet	Others	Total	Total		Trawl net	Purse-seine	Drift/ Gillnet	Others	Total	Total		Trawl net	Purse-seine	Drift/ Gillnet	Others	Total	Total	
sardine	464	33,274	—	—	33,738	1,763	35,501	356	22,619	—	—	22,975	942	23,917	29	31,834	41	—	31,904	59	31,963
ckerel	325	4,300	5	—	4,630	674	5,304	7	2,361	5	—	2,373	106	2,479	3	12,561	6	—	12,570	205	12,775
mbay duck	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
oakers	1,257	239	1	—	1,497	1,279	2,776	1,782	1,100	17	—	2,899	970	3,869	1,125	41	9	—	1,175	414	1,589
rches	1,952	130	—	—	2,082	85	2,167	3,612	53	23	--	3,688	63	3,751	1,749	90	3	—	1,842	106	1,948
mfrets	601	1,216	347	2	2,166	1,044	3,210	203	79	288	—	570	1,358	1,928	123	499	361	—	983	558	1,541
nnies	—	928	273	—	1,201	1,042	2,243	—	862	542	—	1,404	741	2,145	3	529	67	—	599	177	776
naeid prawns	6,676	736	—	—	7,412	320	7,732	6,030	617	—	—	6,647	303	6,950	4,845	180	150	—	5,175	372	5,547
on-penaeid prawns	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
hers	28,598	25,634	1,297	1,173	56,702	12,333	69,035	24,359	28,558	3,808	119	56,844	10,745	67,589	21,427	30,690	1,841	19	53,977	9,506	63,483
TOTAL	39,873	66,457	1,923	1,175	1,09,428	18,540	1,27,968	36,349	56,249	4,683	119	97,400	15,228	1,12,628	29,304	76,424	2,478	19	1,08,225	11,397	1,19,622
o. of perations units	2,01,104	55,326	8,746	3,202		2,41,544		1,76,746	40,454	16,975	5,145		2,58,301		1,42,186	48,928	8,827	155		2,84,426	

able 6 (h). *Estimated marine fish landings from mechanised and non-mechanised fishing crafts in Goa during 1982–'83, 1983–'84 and 1984–'85 (figures in tonnes)*

lame of Fish	1982–'83							1983–'84							1984–'85						
	Mechanised					Non-mech.	Grand Total	Mechanised					Non-mech.	Grand Total	Mechanised					Non-mech.	Grand Total
	Mechanised fishing		Power propulsion					Mechanised fishing		Power propulsion					Mechanised fishing		Power propulsion				
	Trawl net	Purse-seine	Drift/ Gillnet	Others	Total	Total		Trawl net	Purse-seine	Drift/ Gillnet	Others	Total	Total		Trawl net	Purse-seine	Drift/ Gillnet	Others	Total	Total	
Oil sardine	—	1,640	—	—	1,640	3,580	5,220	17	2,383	288	—	2,688	916	3,604	—	1,808	2	—	1,810	215	2,025
Mackerel	—	52	—	3	55	11	66	—	125	—	—	125	131	256	—	2,249	5	—	2,254	453	2,707
Bombay duck	—	—	—	—	—	—	—	12	—	—	—	12	—	12	—	—	—	—	—	—	—
Croakers	2,197	41	2	—	2,240	263	2,503	2,130	24	2	—	2,156	46	2,202	1,825	—	11	—	1,836	316	2,152
Perches	1,292	98	7	—	1,397	116	1,513	973	86	9	—	1,068	4	1,072	1,633	38	—	—	1,671	164	1,835
Pomfrets	159	5	52	—	216	192	408	137	5	42	—	184	83	267	241	24	132	—	397	17	414
Tunnies	—	—	5	—	5	1	6	1	—	24	—	25	—	25	12	—	138	—	150	—	150
Penaeid prawns	5,860	7	1	—	5,868	46	5,914	5,928	--	5	--	5,933	5	5,938	3,688	3	4	—	3,695	208	3,903
Non-penaeid prawns	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Others	12,974	4,094	695	72	17,835	2,409	20,244	17,705	2,081	1,748	—	21,534	1,674	23,208	20,997	3,426	1,573	13	26,009	2,326	28,335
TOTAL	22,482	5,937	762	75	29,256	6,618	35,874	26,903	4,704	2,118	—	33,725	2,859	36,584	28,396	7,548	1,865	13	37,822	3,699	41,521
No. of operations of units	75,139	7,599	9,756	90		64,690		89,132	5,740	28,415		1,23,287	24,600	1,47,887	94,516	7,176	39,644	295	1,41,631	41,893	1,83,524

Table 6 (i). *Estimated marine fish landings by mechanised and non-mechanised fishing crafts in Maharashtra during* 1982-'83, 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Name of fish	1982–'83						
	Mechanised					Non-mech.	Grand Total
	Mech. fishing	Power propulsion					
	Trawl net	Dol net	Drift/ Gillnet	Hooks & lines	Total	Total	
Oil sardine	87	—	—	—	87	235	322
Mackerel	64	—	4	—	68	276	344
Bombay duck	271	47,366	7	—	47,644	1,330	48,974
Croakers	12,093	1,666	684	78	14,521	2,532	17,053
Perches	7,288	38	10	7	7,343	230	7,573
Pomfrets	1,687	7,127	5,135	—	13,949	1,695	15,644
Tunnies	1,357	—	384	—	1,741	1,383	3,124
Penaeid prawns	28,804	4,275	143	—	33,222	1,592	34,814
Non-penaeid prawns	479	39,484	—	—	39,963	4,836	44,799
Others	58,343	17,279	7,387	453	83,462	11,418	94,880
TOTAL	1,10,473	1,17,235	13,754	538	2,42,000	25,527	2,67,527
No. of operations							
Units	1,85,152	2,20,284	87,484	2,201		4,11,121	

Name of fish	1983–'84							
	Mechanised						Non-mech.	Grand Total
	Mech. fishing		Power propulsion					
	Trawl net	Purse-seine	Dol net	Gill net	Hooks & lines	Total	Total	
Oil sardine	—	—	60	52	—	112	776	888
Mackerel	244	—	2	75	—	321	298	619
Bombay duck	737	—	38,492	—	—	39,229	365	39,594
Croakers	11,551	12	3,354	763	80	15,760	2,705	18,465
Perches	5,844	—	51	95	16	6,006	788	6,794
Pomfrets	1,360	—	14,092	7,217	3	22,672	1,026	23,698
Tunnies	284	—	6	529	—	819	1,938	2,757
Penaeid prawns	28,863	—	5,741	4	—	34,608	2,197	36,805
Non-penaeid prawns	450	—	32,127	—	—	32,577	137	32,714
Others	54,927	38	26,783	15,649	873	98,270	8,262	1,06,532
TOTAL	1,04,260	50	1,20,708	24,384	972	2,50,374	18,492	2,68,866
No. of operations								
Units	1,39,195	78	1,84,913	1,67,512	3,576		1,94,704	

Name of fish	1984–'85							
	Mechanised						Non-mech.	Grand Total
	Mech. fishing		Power propulsion					
	Trawl net	Purse-seine	Dol net	Gill net	Hooks & lines	Total	Total	
Oil sardine	46	—	29	47	—	122	788	910
Mackerel	165	168	—	59	—	392	352	744
Bombay duck	830	—	60,329	20	—	61,179	77	61,256
Croakers	11,928	—	5,438	767	47	18,180	2,015	20,195
Perches	4,178	—	132	89	23	4,422	734	5,156
Pomfrets	1,243	—	10,142	5,869	—	17,254	406	17,660
Tunnies	607	—	26	1,819	—	2,452	275	2,727
Penaeid prawns	35,422	16	8,217	50	—	43,705	1,711	45,416
Non-penaeid prawns	602	—	50,447	37	—	51,086	796	51,882
Others	55,147	355	30,618	13,192	597	99,909	4,683	1,04,592
TOTAL	1,10,168	539	1,65,378	21,949	667	2,98,701	11,837	3,10,538
No. of operations								
Units	1,49,770	186	2,09,771	1,71,363	3,093		1,88,845	

ble 6 (j). *Estimated marine fish landings by mechanised and non-mechanised fishing crafts in Gujarat during the years 1982–'83, 1983–'84 and 1984–'85 (figures in tonnes)*

me fish	1982–'83							1983–'84								1984–'85						
	Mechanised					Non-mech.	Grand Total	Mechanised						Non-mech.	Grand Total	Mechanised					Non-mech.	Grand Total
	Mech. fishing	Power propulsion						Mech. fishing		Power propulsion						Mech. fishing		Power propulsion				
	Trawl net	Dol net	Drift/ Gillnet	Hooks & lines	Total	Total		Trawl net	Dol net	Gill net	Hooks & lines	Stake net	Total	Total		Trawl net	Dol net	Gill net	Hooks & lines	Total	Total	
il sardine	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ombay duck	464	14,792	—	—	15,256	23,040	38,296	261	25,048	29	—	37	25,375	24,477	49,852	304	45,639	46	—	45,989	14,435	60,424
erches	1,992	—	343	—	2,335	419	2,754	5821	6	1,386	6	—	7219	597	7,816	8,030	—	398	—	8,428	1,070	9,498
roakers	21,152	527	2,374	—	24,053	935	24,988	18,611	3,873	3,998	31	195	26,708	4,061	30,769	24,439	3,083	4,454	7	31,983	4,443	36,426
omfrets	1,269	131	10,357	—	11,757	1,036	12,793	774	329	5,903	26	3	7,035	2,285	9,320	1,459	682	10,931	—	13,072	1,627	14,699
lackerel	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	35	—	45	—	80	1	81
unnies	22	—	264	—	286	4	290	127	—	1,423	—	—	1,550	27	1,577	236	—	2,385	—	2,621	76	2,697
enaeid prawns	8,763	226	85	—	9,074	3,242	12,316	5,104	987	218	—	—	6,309	3,041	9,350	8,586	1,158	4	—	9,748	4,039	13,787
Non-penaeid prawns	2,360	681	13	—	3,054	2,010	5,064	1,756	1,179	3	—	44	2,982	4,636	7,618	2,094	6,269	5	—	8,368	2,231	10,599
thers	50,645	2,329	29,259	30	82,263	17,673	99,936	54,876	7,779	27,176	56	109	89,996	23,003	1,12,999	8,0763	5,935	28,776	11	1,15,485	25,035	1,40,520
TOTAL	86,667	18,686	42,695	30	1,48,078	48,359	1,96,437	87,330	39,201	40,136	119	388	1,67,174	62,127	2,29,301	1,25,946	62,766	47,044	18	2,35,774	52,957	2,88,731
No. of operations of units	1,23,977	43,699	60,433	210		2,34,494		85,793	37,374	2,82,387	1,420	3,985		5,07,680		92,236	97,788	2,80,772	56		5,14,534	

year's landings. Penaeid prawns with 16% formed the major component followed by croakers (13%) and perches (12%). Landings by non-mechanised crafts in 1984–'85 registered a decrease of about 15,100 tonnes compared to 1,16,800 tonnes of previous year. Perches accounted for about 8% of the landings followed by pomfrets (5%), mackerel (4%) and croakers (4%).

Tamil Nadu

The landings by mechanised crafts in Tamil Nadu during 1983-'84 were estimated at about 1,42,600 tonnes accounting for 51% of the total marine fish landings in the state. This showed an increase of about 22,300 tonnes (19%) over the previous year's landings. Among the commercially important varieties, penaeid prawns formed 9% followed by croakers with 7%. The landings by non-mechanised crafts showed an increase of about 18,800 tonnes (16%) over the landings of the previous year. The landings of mackerel and perches formed 5% each.

The landings by mechanised crafts in 1984–'85 showed a decrease by about 40,700 tonnes from that in 1983–'84 and formed 44% of the total marine fish landings in the state. Penaeid prawns formed 10% of the landings by mechanised crafts, croakers 6% and perches 5%. The landings by non-mechanised crafts showed a decrease of about 3,800 tonnes (3%) from the previous year's landings of 1,34,500 tonnes. Among the commercially important varieties, perches formed 4%, mackerel 4% and croakers 3% of the landings by non-mechanised crafts.

Pondicherry

The landings by mechanised crafts in Pondicherry in 1983–'84 formed 37% of the total marine fish landings in the region and showed an increase of about 1,000 tonnes over the landings of 4,600 tonnes of previous year. Among the commercially important varieties, perches contributed 16% of the total landings by mechanised crafts and penaeid prawns 8%. Landings by non-mechanised crafts in 1983–'84 also showed an increase over that of previous year, by about 1,100 tonnes (13%). Mackerel formed 9% of the landings by non-mechanised crafts and oil sardine 8%.

In Pondicherry the landings by mechanised crafts in 1984–'85 were estimated at about 4,300 tonnes and formed 29% of the total landings in the region. This showed a decrease of about 1,200 tonnes (22%) from the landings of the previous year. Perches formed 15% of the landings by mechanised crafts, penaeid prawns 10% and croakers 5%. The landings by non-mechanised crafts during 1984–'85 showed an increase of about 1,100 tonnes (11%) over the landings of 9,500 tonnes of the previous year. Mackerel formed 9% followed by croakers (5%) and oil sardine (3%).

Kerala

The landings by mechanised crafts in Kerala during 1983–'84 accounted for 33% of the total landings in the state and showed a decrease of about 54,700 tonnes from 1,79,200 tonnes of previous year. Landings by trawlers contributed 56% of the total landings by mechanised crafts, and purse-seiners contributed 11%. Among the major varieties, oil sardine accounted for 27% of the total landings by mechanised crafts followed by penaeid prawns (16%) and perches (4%). Landings by non-mechanised crafts in 1983–'84 contributed 67% of the total landings in the state and showed an increase of about 89,400 tonnes over the landings of 1,69,200 tonnes of 1982–'83. Among the commercially important varieties, oil sardine accounted for 45% of the landings by non-mechanised carfts in the state. The landings of mackerel accounted for 4% and penaeid prawns 3%.

Landings by mechanised crafts in 1984–'85 were estimated at 2,72,700 tonnes showing a substantial increase over the corresponding landings of previous year by about 1,48,200 tonnes and accounted for 72% of the total landings in the state. The landings by trawlers accounted for 36% of the total landings by mechanised crafts, while the contribution from purse-seiners was 6%, and 58% came from units with power propulsion. The landings by units with power propulsion during 1984–'85 showed a substantial increase by about 1,17,800 tonnes from the previous year's landings of 40,200 tonnes. Among the commercially important varieties, oil sardine contributed 99,400 tonnes accounting for 36% of the total mechanised landings. Penaeid prawns contributed 35,000 tonnes accounting for 13% and perches about 26,500 tonnes (10%). The landings by non-mechanised crafts in 1984–'85 estimated at 1,04,800 tonnes accounted for 28% of the total landings in the state and registered a reduction in the landings by about 1,53,800 tonnes from the corresponding landings of the previous year. Among the commercially important varieties of fish, oil sardine accounted for 28% by the non-mechanised crafts and mackerel 6%.

Karnataka

Landings by mechanised crafts in Karnataka in 1983–'84 accounted for 86% of the total marine fish

landings in the state. This showed a reduction of about 12,000 tonnes (11%) from the corresponding landings of previous year. 58% of the landings by the mechanised crafts was contributed by purse-seiners and 37% by trawlers. Among the commercially important varieties, oil sardine accounted for 24% and penaeid prawns 7%. The landings by the non-mechanised crafts in 1983–'84 accounting for about 14% of the total landings showed a reduction by 3,300 tonnes from that of previous year. Pomfrets formed 9% of the landings by non-mechanised crafts while oil sardine and croakers formed 6% each.

The landings by mechanised crafts in 1984–'85 accounted for 90% of the total landings in the state and showed an increase of 10,800 tonnes over the landings of previous year. 71% of the mechanised landings was contributed by purse-seiners and 27% by trawlers. Among the commercially important varieties of fish, oil sardine contributed 29%, mackerel 12% and penaeid prawns 5%. The landings of non-mechanised units in Karnataka during 1984–'85 accounted for 10% of the total landings and showed a reduction by about 3,800 tonnes from the landings of the previous year. Pomfrets formed 5% of the landings by the non-mechanised crafts, croakers 4% and mackerel 2%.

Goa

Landings by mechanised crafts in Goa in 1983–'84 accounted for 92% of the total landings in the territory and this registered an increase of about 4,500 tonnes over the corresponding landings of 1982–'83. 80% of the landings by the mechanised crafts was contributed by trawlers and 14% by purse-seiners. Among the major varieties, penaeid prawns contributed 18% of the total landings by the mechanised crafts, oil sardine 8%, croakers 6% and perches 3%. The landings by the non-mechanised crafts accounted for 8% of the total landings in the territory. Oil sardine (900 tonnes) accounted for 32%.

The landings by mechanised crafts in 1984–'85 was estimated at 37,700 tonnes accounting for 91% of the total landings in the territory and showed a marginal increase of about 1,200 tonnes over that of the previous year. Trawlers contributed 75% of the landings by the mechanised vessels and purse-seiners 20%. Among the major varieties, penaeid prawns accounted for 10% of the total landings in this category, mackerel 6%, croakers 5% and oil sardine 5%. The non-mechanised crafts landed 3,700 tonnes during 1984–'85 showing an increase of 800 tonnes over that of previous year. Mackerel accounted for 12% of the landings by the non-mechanised crafts, croakers 9%, oil sardine 6% and penaeid prawns 6%.

Maharashtra

Landings by mechanised crafts in Maharashtra during 1983–'84 accounted for 93% of the total landings in the state and showed an increase of about 8,400 tonnes (3%) over the previous year's landings. Trawlers contributed 42% of the total landings by the mechanised crafts in the state. Crafts with power propulsion contributed about 58% of this landings. 'Dol' netters contributed 48% and gill netters about 10% of the total landings by the mechanised crafts. Among the commercially important varieties, bombay duck accounted for 16% of the total landings, penaeid prawns 14%, non-penaeid prawns 13%, pomfrets 9% and croakers 6%. Non-mechanised crafts landed about 18,500 tonnes during 1983–'84 which showed a decrease by about 7,000 tonnes from that of previous year. Croakers accounted for 15% of the landings, penaeid prawns 12%, tunnies 10% and pomfrets 6%.

In 1984–'85 the landings by the mechanised crafts were estimated at 2,98,700 tonnes which accounted for 96% of the total marine fish landings in the state showing an increase of about 48,300 tonnes over the corresponding landings of the previous year. The landings by trawlers accounted for 37% of the total landings in the mechanised category and crafts with power propulsion contributed 63%. Out of the total landings by mechanised crafts 'dol' netters contributed 55% and gill netters 7%. Among the commercially important varieties, bombay duck accounted for 20% of the landings by the mechanised crafts, non-penaeid prawns 17%, penaeid prawns 15%, croakers 6% and pomfrets 6%. The non-mechanised crafts landed about 11,800 tonnes during 1984–'85 accounting for 4% of the total landings in the state. Croakers accounted for 17% of the landings in this category, penaeid prawns 14% and non-penaeid prawns 7%.

Gujarat

In Gujarat during 1983–'84 the landings by the mechanised crafts accounted for 73% of the total landings in the state, registering an increase of about 19,000 tonnes over the corresponding landings of the previous year. The trawlers contributed 52% of the landings by the mechanised crafts in the state. Among the units with power propulsion, 'dol' netters contributed 23% and gill netters 24%. Among the commercially important varieties of fish, croakers accounted for 16%,

bombay duck 15%, pomfrets 4% and penaeid prawns 4%. The non-mechanised crafts landed an estimated quantity of 62,100 tonnes which showed an increase of about 13,800 tonnes over that of previous year. Bombay duck with 39% formed the major component. Non-penaeid prawns accounted for 7%, croakers 7% and penaeid prawns 5%.

The landings by the mechanised crafts in 1984–'85 estimated at 2,35,800 tonnes, accounted for 82% of the total marine fish landings in the state and showed an increase of 68,600 tonnes over that of previous year. Trawlers contributed 53% of the landings, 'dol' netters accounted for 27% and gill netters for 20%. Among the commercially important varieties, bombay duck contributed 20%, croakers 14%, pomfrets 6%, penaeid prawns 4% and non-penaeid prawns 4%. The landings by the non-mechanised crafts, estimated at about 53,000 tonnes, accounted for 18% of the total landings in the state showing a reduction by about 9,200 tonnes from that of the previous year. Bombay duck with 27% formed the major variety of fish followed by croakers (8%), penaeid prawns (8%) and non-penaeid prawns (4%).

Landings of mechanised boats at major centres

Tables 7 (a to n) give the estimated gear-wise landings by mechanised boats and Tables 8 (a to n) give the estimated quarter-wise landings by mechanised boats at major landing centres in the country.

Table 7 (a) *Composition of marine fish landings from mechanised boats at Visakhapatnam Outer Harbour during* 1982–'83, 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Sl. No.		Name of fish	1982–'83 Trawl net	1983–'84 Trawl net	1984–'85 Trawl net
1		2	3	4	5
1.		Elasmobranchs			
	a)	Sharks	15	11	9
	b)	Skates	35	33	27
	c)	Rays	79	72	97
2.		Eels	31	42	101
3.		Cat fishes	186	134	126
4.		Clupeids			
	a)	Wolf herring	6	7	8
	b)	Oil sardine	—	—	—
	c)	Other sardines	2	35	1
	d)	Hilsa shad	—	—	—
	e)	Other shads	—	—	—
	f)	Anchovies			
		Coilia	—	—	—
		Setipinna	—	—	—
		Stolephorus	189	184	97
		Thrissina	—	—	—
		Thryssa	60	56	94
	g)	Other clupeids	8	23	12
5.		Bombay duck	8	2	3
6.		Lizard fishes	966	589	547
7.		Half beaks & Full beaks	—	—	—
8.		Flying fishes	—	—	—
9.		Perches			
	a)	Rock cods	2	1	—
	b)	Snappers	1	—	—
	c)	Pig-face breams	—	—	—
	d)	Threadfin breams	532	1,419	536
	e)	Other perches	457	986	663
10.		Goat fishes	216	250	305
11.		Threadfins	28	44	54
12.		Croakers	349	595	565
13.		Ribbon fishes	297	673	556
14.		Carangids			
	a)	Horse mackerel	—	2	—
	b)	Scads	68	307	71
	c)	Leather-jackets	—	—	—
	d)	Other carangids	106	50	26
15.		Silver bellies	368	536	320
16.		Big-jawed jumper	14	143	51
17.		Pomfrets			
	a)	Black pomfret	8	4	8
	b)	Silver pomfret	5	3	33
	c)	Chinese pomfret	—	—	—
18.		Mackerels			
	a)	Indian mackerel	13	92	10
	b)	Other mackerels	—	—	—
19.		Seer fishes			
	a)	*S. commerson*	—	—	—
	b)	*S. guttatus*	2	1	—
	c)	*S. lineolatus*	—	—	—
	d)	*Acanthocybium* spp.	—	—	—
20.		Tunnies			
	a)	*E. affinis*	—	—	—
	b)	*Auxis* spp.	—	—	—
	c)	*K. pelamis*	—	—	8
	d)	*T. tonggol*	—	—	—
	e)	Other tunnies	—	—	—
21.		Bill fishes	—	—	—
22.		Barracudas	14	5	7
23.		Mullets	—	—	—
24.		Unicorn cod	—	—	—
25.		Flat fishes			
	a)	Halibut	12	2	9

1	2	3	4	5
	b) Flounders	—	—	—
	c) Soles	47	60	88
26.	Crustaceans			
	a) Penaeid prawns	673	1,108	890
	b) Non-penaeid prawns	5	49	50
	c) Lobsters	3	—	—
	d) Crabs	133	402	531
	e) Stomatopods	9	80	227
27.	Cephalopods	229	239	140
28.	Miscellaneous	44	57	68
	TOTAL	5,220	8,296	6,338

Table 7 (b). *Composition of marine fish landings from mechanised boats at Kakinada Fisheries Harbour during* 1982–'83, 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1982–'83 Trawl net	1983–'84 Trawl net	1984–'85 Trawl net
1	2	3	4	5
1.	Elasmobranchs			
	a) Sharks	38	56	39
	b) Skates	80	45	103
	c) Rays	192	251	327
2.	Eels	196	231	177
3.	Cat fishes	245	237	278
4.	Clupeids			
	a) Wolf herring	1	3	1
	b) Oil sardine	—	—	—
	c) Other sardines	95	—	14
	d) Hilsa shad	—	—	—
	e) Other shads	1	35	8
	f) Anchovies			
	Coilia	7	9	14
	Setipinna	—	—	—
	Stolephours	514	721	937
	Thrissina	—	—	—
	Thryssa	261	348	493
	g) Other clupeids	386	162	190
5.	Bombay duck	357	83	97
6.	Lizard fishes	238	332	448
7.	Half beaks & Full beaks	—	—	—
8.	Flying fishes	—	—	—
9.	Perches			
	a) Rock cods	—	3	6
	b) Snappers	7	11	48
	c) Pig-face breams	—	—	—
	d) Threadfin breams	1,087	1,052	707
	e) Other perches	1,643	1,594	910
10.	Goat fishes	205	177	248
11.	Threadfins	24	65	108
12.	Croakers	583	1,140	1,219
13.	Ribbon fishes	861	1,424	1,079
14.	Carangids			
	a) Horse mackerel	—	—	—
	b) Scads	2,696	1,349	557
	c) Leather-jackets	—	—	—
	d) Other carangids	109	201	207
15.	Silver bellies	947	2,000	1,413
16.	Big-jawed jumper	43	164	46
17.	Pomfrets			
	a) Black pomfret	11	7	1
	b) Silver pomfret	8	5	26
	c) Chinese pomfret	—	—	—
18.	Mackerels			
	a) Indian mackerel	112	41	36
	b) Other mackerels	—	—	—
19.	Seer fishes			
	a) *S. commerson*	—	2	—
	b) *S. guttatus*	—	2	1
	c) *S. lineolatus*	—	—	—
	d) *Acanthocybium* spp.	—	—	—
20.	Tunnies			
	a) *E. affinis*	—	—	—
	b) *Auxis* spp.	—	—	—
	c) *K. pelamis*	—	—	—
	d) *T. tonggol*	—	—	—
	e) Other tunnies	—	—	—
21.	Bill fishes	—	—	—
22.	Barracudas	74	111	88
23.	Mullets	—	1	—
24.	Unicorn cod	—	—	—
25.	Flat fishes			
	a) Halibut	2	11	28
	b) Flounders	13	77	33
	c) Soles	247	354	236
26.	Crustaceans			
	a) Penaeid prawns	2,671	2,961	2,388
	b) Non-penaeid prawns	1,029	2,455	530
	c) Lobsters	—	—	5
	d) Crabs	417	761	455
	e) Stomatopods	375	401	250
27.	Cephalopods	114	184	140
28.	Miscellaneous	321	327	248
	TOTAL	16,210	19,393	14,139

Table 7 (c). *Composition of marine fish landings from mechanised boats at Pudumanikuppam during* 1982–'83, 1983–'84 and 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1982–'83 Trawl net	1982–'83 Gill net	1982–'83 Total	1983–'84 Trawl net	1983–'84 Gill net	1983–'84 Total	1984–'85 Trawl net	1984–'85 Gill net	1984–'85 Total
1	2	3	4	5	6	7	8	9	10	11
1.	Elasmobranchs									
a)	Sharks	31	26	57	14	9	23	375	83	458
b)	Skates	12	—	12	23	1	24	80	13	93
c)	Rays	94	10	104	46	8	54	105	15	120
2.	Eels	14	1	15	—	—	—	5	—	5
3.	Cat fishes	5	3	8	15	2	17	270	15	285
4.	Clupeids									
a)	Wolf herring	2	—	2	3	—	3	35	7	42
b)	Oil sardine	—	—	—	—	—	—	—	—	—
c)	Other sardines	3	—	3	9	—	9	—	—	—
d)	Hilsa shad	—	—	—	—	—	—	—	—	—
e)	Other shads	—	—	—	—	—	—	—	—	—
f)	Anchovies							5		5
	Coilia	—	—	—	—	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—	—
	Stolephorus	13	—	13	87	—	87	228	—	228
	Thrissina	—	—	—	—	—	—	—	—	—
	Thryssa	23	—	23	17	—	17	43	—	43
g)	Other clupeids	15	5	20	14	2	16	2	—	2
5.	Bombay duck	—	—	—	—	—	—	—	—	—
6.	Lizard fishes	729	—	729	288	—	288	927	—	927
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—
9.	Perches									
a)	Rock cods	—	—	—	—	—	—	174	28	202
b)	Snappers	—	—	—	2	2	4	165	28	193
c)	Pig-face breams	7	—	7	4	—	4	—	—	—
d)	Threadfin breams	1,524	—	1,524	1,271	—	1,271	686	—	686
e)	Other perches	728	—	728	677	—	677	273	—	273
10.	Goat fishes	91	—	91	62	—	62	99	—	99
11.	Threadfins	3	—	3	17	—	17	34	10	44
12.	Croakers	224	—	224	405	—	405	335	—	335
13.	Ribbon fishes	303	—	303	164	—	164	609	—	609
14.	Carangids									
a)	Horse mackerel	—	—	—	—	—	—	—	—	—
b)	Scads	203	—	203	394	—	394	52	—	52
c)	Leather-jackets	—	1	1	6	9	15	81	—	81
d)	Other carangids	26	1	27	34	3	37	498	6	504
15.	Silver bellies	1,336	—	1,336	1,532	—	1,532	1,218	—	1,218
16.	Big-jawed jumper	1	—	1	2	—	2	50	3	53
17.	Pomfrets									
a)	Black pomfret	4	1	5	10	1	11	55	12	67
b)	Silver pomfret	—	—	—	—	—	—	131	7	138
c)	Chinese pomfret	—	—	—	—	—	—	—	—	—

1	2	3	4	5	6	7	8	9	10	11
18.	Mackerels									
a)	Indian mackerel	8	—	8	63	—	63	6	—	6
b)	Other mackerels	—	—	—	—	—	—	—	—	—
19.	Seer fishes									
a)	*S. commerson*	2	38	40	11	35	46	182	42	224
b)	*S. guttatus*	1	18	19	—	4	4	233	31	264
c)	*S. lineolatus*	—	12	12	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—
20.	Tunnies									
a)	*E. affinis*	1	8	9	2	7	9	138	15	153
b)	*Auxis* spp.	—	—	—	1	—	1	40	—	40
c)	*K. pelamis*	—	1	1	13	—	13	44	—	44
d)	*T. tonggol*	—	—	—	1	—	1	—	—	—
e)	Other tunnies	—	—	—	—	—	—	—	—	—
21.	Bill fishes	—	26	26	—	23	23	73	4	77
22.	Barracudas	65	—	65	55	—	55	124	—	124
23.	Mullets	—	—	—	—	—	—	—	—	—
24.	Unicorn cod	—	—	—	—	—	—	—	—	—
25.	Flat fishes									
a)	Halibut	4	—	4	3	—	3	24	—	24
b)	Flounders	4	—	4	—	—	—	—	—	—
c)	Soles	32	—	32	24	—	24	23	—	23
26.	Crustaceans									
a)	Penaeid prawns	1,181	—	1,181	770	—	770	410	—	410
b)	Non-penaeid prawns	—	—	—	—	—	—	—	—	—
c)	Lobsters	30	—	30	68	—	68	130	—	130
d)	Crabs	232	—	232	134	—	134	247	—	247
e)	Stomatopods	28	—	28	35	—	35	—	—	—
27.	Cephalopods	535	—	535	418	—	418	165	—	165
28.	Miscellaneous	1,577	2	1,579	2,605	3	2,608	520	21	541
	TOTAL	9,091	153	9,244	9,299	109	9,408	8,894	340	9,234
	No. of operations of fishing units	34,567	1,331		29,897	836		36,864	1,650	

Table 7 (d). *Composition of marine fish landings from mechanised boats at Cuddalore Fisheries Harbour during the years* 1982–'83, 1983–'84 and 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1982–'83			1983–'84			1984–'85		
		Trawl net	Gill net	Total	Trawl net	Gill net	Total	Trawl net	Gill net	Total
1	2	3	4	5	6	7	8	9	10	11
1.	Elasmobranchs									
a)	Sharks	—	482	482	—	84	84	—	130	130
b)	Skates	3	4	7	—	—	—	—	—	—
c)	Rays	—	24	24	—	11	11	1	21	22
2.	Eels	—	—	—	—	—	—	—	—	—
3.	Cat fishes	—	—	—	—	—	—	—	—	—
4.	Clupeids									
a)	Wolf herring	—	—	—	—	—	—	—	—	—
b)	Oil sardine	—	—	—	—	—	—	—	—	—

1	2	3	4	5	6	7	8	9	10	11
c)	Other sardines	—	—	—	—	—	—	—	—	—
d)	Hilsa shad	—	—	—	—	—	—	—	—	—
e)	Other shads	—	—	—	—	—	—	—	—	—
f)	Anchovies									
	Coilia	—	—	—	—	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—	—
	Stolephorus	22	—	22	178	—	178	138	—	138
	Thrissina	—	—	—	—	—	—	—	—	—
	Thryssa	—	—	—	55	—	55	20	—	20
g)	Other clupeids	—	37	37	89	—	89	96	—	96
5.	Bombay duck	—	—	—	—	—	—	—	—	—
6.	Lizard fishes	225	—	225	375	—	375	326	—	326
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—
9.	Perches									
a)	Rock cods	—	6	6	—	—	—	—	—	—
b)	Snappers	—	—	—	—	—	—	—	—	—
c)	Pig-face breams	—	—	—	—	—	—	—	—	—
d)	Threadfin breams	328	—	328	256	—	256	152	—	152
e)	Other perches	57	—	57	148	—	148	97	—	97
10.	Goat fishes	40	—	40	38	—	38	33	—	33
11.	Threadfins	—	—	—	6	—	6	—	—	—
12.	Croakers	142	—	142	99	—	99	269	—	269
13.	Ribbon fishes	—	—	—	27	—	27	7	—	7
14.	Carangids									
a)	Horse mackerel	—	—	—	—	—	—	—	—	—
b)	Scads	—	—	—	—	—	—	—	—	—
c)	Leather-jackets	—	9	9	—	4	4	—	4	4
d)	Other carangids	—	20	20	—	11	11	44	1	45
15.	Silver bellies	826	—	826	1,440	—	1,440	831	—	831
16.	Big-jawed jumper	—	—	—	—	—	—	—	—	—
17.	Pomfrets									
a)	Black pomfret	—	—	—	—	—	—	—	—	—
b)	Silver pomfret	—	—	—	—	—	—	—	—	—
c)	Chinese pomfret	—	—	—	—	1	1	—	—	—
18.	Mackerels									
a)	Indian mackerel	—	—	—	—	4	4	—	—	—
b)	Other mackerels	—	—	—	—	—	—	—	—	—
19.	Seer fishes									
a)	*S. commerson*	—	701	701	—	136	136	—	101	101
b)	*S. guttatus*	—	—	—	—	—	—	—	—	—
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—
20.	Tunnies									
a)	*E. affinis*	—	408	408	—	47	47	—	62	62
b)	*Auxis* spp.	—	—	—	—	—	—	—	—	—
c)	*K. pelamis*	—	—	—	19	—	19	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	—	—
e)	Other tunnies	—	—	—	—	—	—	—	—	—
21.	Bill fishes	—	64	64	—	7	7	—	24	24
22.	Barracudas	—	23	23	—	5	5	8	3	11

1	2	3	4	5	6	7	8	9	10	11
23.	Mullets	—	—	—	—	—	—	—	—	—
24.	Unicorn cod	—	—	—	—	—	—	—	—	—
25.	Flat fishes									
a)	Halibut	—	—	—	—	—	—	—	—	—
b)	Flounders	—	—	—	—	—	—	—	—	—
c)	Soles	20	—	20	11	—	11	16	—	16
26.	Crustaceans									
a)	Penaeid prawns	234	—	234	296	—	296	363	—	363
b)	Non-penaeid prawns	—	—	—	—	—	—	—	—	—
c)	Lobsters	—	—	—	—	—	—	—	—	—
d)	Crabs	197	—	197	64	—	64	102	—	102
e)	Stomatopods	—	—	—	26	—	26	12	—	12
27.	Cephalopods	54	—	54	84	—	84	31	—	31
28.	Miscellaneous	188	3	191	173	—	173	84	—	84
	TOTAL	2,336	1,781	4,117	3,384	310	3,694	2,630	346	2,976
	No. of operations of fishing units	9,232	4,327		11,239	1,250		9,218	1,196	

Table 7 (e). *Composition of marine fish landings from mechanised boats at Nagapattinam during* 1982–'83, 1983–'84 and 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1982–'83 Trawl net	Gill net	Total	1983–'84 Trawl net	Gill net	Total	1984–'85 Trawl net	Gill net	Total
1	2	3	4	5	6	7	8	9	10	11
1.	Elasmobranchs									
a)	Sharks	4	—	4	—	—	—	41	—	41
b)	Skates	26	—	26	1	—	1	—	—	—
c)	Rays	295	—	295	604	—	604	361	—	361
2.	Eels	37	—	37	27	—	27	5	—	5
3.	Cat fishes	175	—	175	150	—	150	142	—	142
4.	Clupeids									
a)	Wolf herring	—	—	—	9	—	9	—	—	—
b)	Oil sardine	—	—	—	4	—	4	2	—	2
c)	Other sardines	—	—	—	—	—	—	2	—	2
d)	Hilsa shad	—	—	—	—	—	—	—	—	—
e)	Other shads	—	—	—	—	—	—	—	—	—
f)	Anchovies									
	Coilia	191	—	191	531	—	531	259	—	259
	Setipinna	—	—	—	—	—	—	—	—	—
	Stolephorus	293	—	293	888	—	888	338	—	338
	Thrissina	—	—	—	—	—	—	—	—	—
	Thryssa	225	—	225	409	—	409	341	—	341
g)	Other clupeids	545	—	545	726	—	726	511	—	511
5.	Bombay duck	—	—	—	—	—	—	—	—	—
6.	Lizard fishes	196	—	196	268	—	268	283	—	283
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—
9.	Perches									
a)	Rock cods	1	—	1	—	—	—	—	—	—

1	2	3	4	5	6	7	8	9	10	11
b)	Snappers	—	—	—	—	—	—	—	—	—
c)	Pig-face breams	—	—	—	—	—	—	—	—	—
d)	Threadfin breams	525	—	525	467	—	467	304	—	304
e)	Other perches	280	—	280	601	1	602	222	—	222
10.	Goat fishes	32	—	32	79	—	79	58	—	58
11.	Threadfins	—	—	—	—	—	—	9	—	9
12.	Croakers	866	—	866	1,566	—	1,566	1,058	—	1,058
13.	Ribbon fishes	235	—	235	253	—	253	110	—	110
14.	Carangids									
a)	Horse mackerel	—	—	—	—	—	—	—	—	—
b)	Scads	—	—	—	—	—	—	—	—	—
c)	Leather-jackets	—	—	—	—	—	—	4	—	4
d)	Other carangids	233	—	233	328	—	328	293	—	293
15.	Silver bellies	967	—	967	3,025	—	3,025	1,772	—	1,772
16.	Big-jawed jumper	46	—	46	4	—	4	17	—	17
17.	Pomfrets									
a)	Black pomfret	1	—	1	13	—	13	1	—	1
b)	Silver pomfret	37	—	37	37	—	37	37	—	37
c)	Chinese pomfret	—	—	—	—	—	—	—	—	—
18.	Mackerels									
a)	Indian mackerel	2	—	2	8	—	8	7	—	7
b)	Other mackerels	—	—	—	—	—	—	—	—	—
19.	Seer fishes									
a)	*S. commerson*	—	—	—	5	—	5	1	—	1
b)	*S. guttatus*	—	—	—	1	—	1	—	—	—
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—
20.	Tunnies									
a)	*E. affinis*	—	—	—	—	—	—	—	—	—
b)	*Auxis* spp.	—	—	—	—	—	—	—	—	—
c)	*K. pelamis*	—	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	—	—
e)	Other tunnies	—	—	—	—	—	—	—	—	—
21.	Bill fishes	—	—	—	—	—	—	—	—	—
22.	Barracudas	95	—	95	98	—	98	60	—	60
23.	Mullets	2	—	2	—	—	—	22	—	22
24.	Unicorn cod	—	—	—	—	—	—	16	—	16
25.	Flat fishes									
a)	Halibut	99	—	99	107	—	107	57	—	57
b)	Flounders	—	—	—	—	—	—	26	—	26
c)	Soles	193	—	193	220	—	220	220	—	220
26.	Crustaceans									
a)	Penaeid prawns	748	—	748	1,543	—	1,543	1,073	—	1,073
b)	Non-penaeid prawns	65	—	65	42	—	42	122	—	122
c)	Lobsters	20	—	20	15	—	15	23	—	23
d)	Crabs	202	—	202	402	—	402	450	—	450
e)	Stomatopods	16	—	16	1	—	1	4	—	4
27.	Cephalopods	77	—	77	65	—	65	86	—	86
28.	Miscellaneous	253	—	253	357	—	357	528	—	528
	TOTAL	6,982	—	6,982	12,854	1	12,855	8,865	—	8,865

Table 7 (f). *Composition of marine fish landings from mechanised boats at Mandapam during 1982–'83, 1983-'84 and 1984–'85 (figures in tonnes)*

Sl. No.	Name of fish	1982–'83 Trawl net	1983–'84 Trawl net	1984–'85 Trawl net
1	2	3	4	5
1.	Elasmobranchs			
a)	Sharks	—	1	—
b)	Skates	—	—	—
c)	Rays	236	208	332
2.	Eels	—	4	—
3.	Cat fishes	48	50	60
4.	Clupeids			
a)	Wolf herring	2	5	—
b)	Oil sardine	—	27	6
c)	Other sardines	31	41	64
d)	Hilsa shad	6	8	—
e)	Other shads	5	14	33
f)	Anchovies			
	Coilia	—	2	—
	Setipinna	—	—	—
	Stolephorus	—	3	4
	Thrissina	—	—	—
	Thryssa	27	14	23
g)	Other clupeids	117	42	31
5.	Bombay duck	—	—	—
6.	Lizard fishes	10	6	2
7.	Half beaks & Full beaks	—	—	—
8.	Flying fishes	—	—	—
9.	Perches			
a)	Rock cods	—	—	—
b)	Snappers	—	—	—
c)	Pig-face breams	20	23	11
d)	Threadfin breams	2	1	2
e)	Other perches	94	109	146
10.	Goat fishes	73	96	103
11.	Threadfins	—	2	2
12.	Croakers	319	348	348
13.	Ribbon fishes	7	3	3
14.	Carangids			
a)	Horse mackerel	—	—	—
b)	Scads	—	—	—
c)	Leather-jackets	1	1	2
d)	Other carangids	40	38	78
15.	Silver bellies	3,659	2,910	2,419
16.	Big-jawed jumper	1	1	1
17.	Pomfrets			
a)	Black pomfret	3	—	—
b)	Silver pomfret	13	16	4
c)	Chinese pomfret	—	—	1
18.	Mackerels			
a)	Indian mackerel	—	—	2
b)	Other mackerels	—	—	—
19.	Seer fishes			
a)	*S. commerson*	—	—	—
b)	*S. guttatus*	—	—	—
c)	*S. lineolatus*	—	—	—
d)	*Acanthocybium* spp.	—	—	—
20.	Tunnies			
a)	*E. affinis*	—	—	—
b)	*Auxis* spp.	—	—	—
c)	*C. pelamis*	—	—	—
d)	*T. tonggol*	—	1	—
e)	Other tunnies	—	—	—
21.	Bill fishes	—	—	—
22.	Barracudas	—	—	—
23.	Mullets	—	14	8
24.	Unicorn cod	—	—	—
25.	Flat fishes			
a)	Halibut	—	—	—
b)	Flounders	—	—	—
c)	Soles	42	55	60
26.	Crustaceans			
a)	Penaeid prawns	681	794	1,031
b)	Non-penaeid prawns	—	2	—
c)	Lobsters	—	—	—
d)	Crabs	198	272	732
e)	Stomatopods	9	—	—
27.	Cephalopods	79	87	148
28.	Miscellaneous	640	1,798	1,654
	TOTAL	6,363	6,996	7,310

Table 7 (g). *Composition of marine fish landings from mechanised boats at Rameswaram during* 1982–'83, 1983–'84 and 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1982–'83			1983–'84			1984–'85		
		Trawl net	Gill net	Total	Trawl net	Gill net	Total	Trawl net	Gill net	Total
1	2	3	4	5	6	7	8	9	10	11
1.	Elasmobranchs									
a)	Sharks	—	—	—	—	—	—	—	—	—
b)	Skates	—	—	—	—	—	—	—	—	—
c)	Rays	2,330	—	2,330	3,249	—	3,249	2,861	—	2,861
2.	Eels	—	—	—	—	—	—	—	—	—
3.	Cat fishes	202	—	202	225	—	225	342	—	342
4.	Clupeids									
a)	Wolf herring	—	1	1	—	—	—	—	—	—
b)	Oil sardine	—	—	—	38	—	38	—	—	—
c)	Other sardines	52	—	52	387	—	387	512	—	512
d)	Hilsa shad	5	—	5	48	—	48	—	—	—
e)	Other shads	6	—	6	62	—	62	227	—	227
f)	Anchovies									
	Coilia	9	—	9	—	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—	—
	Stolephorus	—	—	—	—	—	—	3	—	3
	Thrissina	—	—	—	—	—	—	—	—	—
	Thryssa	15	—	15	12	—	12	—	—	—
g)	Other clupeids	351	—	351	90	—	90	97	—	97
5.	Bombay duck	—	—	—	—	—	—	—	—	—
6.	Lizard fishes	156	—	156	245	—	245	39	—	39
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—
9.	Perches									
a)	Rock cods	2	—	2	1	—	1	—	—	—
b)	Snappers	—	—	—	—	—	—	—	—	—
c)	Pig-face breams	—	—	—	—	—	—	—	—	—
d)	Thread fin breams	—	—	—	1	—	1	1	—	1
e)	Other perches	101	—	101	331	—	331	515	—	515
10.	Goat fishes	344	—	344	607	—	607	397	—	397
11.	Threadfins	—	—	—	—	—	—	73	—	73
12.	Croakers	2,754	—	2,754	2,533	—	2,533	1,544	—	1,544
13.	Ribbon fishes	3	—	3	—	—	—	—	—	—
14.	Carangids									
a)	Horse mackerel	—	—	—	—	—	—	—	—	—
b)	Scads	—	—	—	—	—	—	—	—	—
c)	Leather-jackets	—	—	—	—	—	—	—	—	—
d)	Other carangids	103	—	103	60	—	60	187	—	187
15.	Silver bellies	12,373	—	12,373	14,029	—	14,029	10,012	—	10,012
16.	Big-jawed jumper	—	—	—	4	—	4	—	—	—
17.	Pomfrets									
a)	Black pomfret	—	—	—	—	—	—	—	—	—
b)	Silver pomfret	85	—	85	23	—	23	5	—	5
c)	Chinese pomfret	—	—	—	—	—	—	—	—	—

1	2	3	4	5	6	7	8	9	10	11
18.	Mackerels	—	—	—	—	—	—	—	—	—
a)	Indian mackerel	—	—	—	1	—	1	14	—	14
b)	Other mackerels	—	—	—	—	—	—	—	—	—
19.	Seer fishes									
a)	*S. commerson*	—	—	—	—	—	—	—	—	—
b)	*S. guttatus*	—	—	—	—	—	—	—	—	—
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—
20.	Tunnies									
a)	*E. affinis*	—	—	—	—	—	—	—	—	—
b)	*Auxis* spp.	—	—	—	—	—	—	—	—	—
c)	*K. pelamis*	—	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	—	—
e)	Other tunnies	—	—	—	—	—	—	—	—	—
21.	Bill fishes	—	—	—	—	—	—	—	—	—
22.	Barracudas	—	—	—	1	—	1	1	—	1
23.	Mullets	—	—	—	3	—	3	—	—	—
24.	Unicorn cod	—	—	—	—	—	—	—	—	—
25.	Flat fishes									
a)	Halibut	15	—	15	—	—	—	—	—	—
b)	Flounders	—	—	—	—	—	—	—	—	—
c)	Soles	160	—	160	179	—	179	126	—	126
26.	Crustaceans									
a)	Penaeid prawns	1,905	—	1,905	2,429	—	2,429	2,552	—	2,552
b)	Non-penaeid prawns	—	—	—	—	—	—	—	—	—
c)	Lobsters	1	—	1	—	—	—	—	—	—
d)	Crabs	696	—	696	1,016	—	1,016	868	—	868
e)	Stomatopods	—	—	—	30	—	30	215	—	215
27.	Cephalopods	202	—	202	262	—	262	187	—	187
28.	Miscellaneous	943	—	943	1,227	—	1,227	717	—	717
	TOTAL	22,813	1	22,814	27,093	—	27,093	21,495	—	21,495

Table 7 (h). *Composition of marine fish landings from mechanised boats at Tuticorin Fisheries Harbour during 1982–'83, 1983–'84 and 1984–'85 (figures in tonnes)*

Sl. No.	Name of fish	1982–'83 Trawl net	Gill net	Total	1983–'84 Trawl net	1984–'85 Trawl net
1	2	3	4	5	6	7
1.	Elasmobranchs					
a)	Sharks	381	—	381	119	—
b)	Skates	—	—	—	—	—
c)	Rays	512	—	512	208	11
2.	Eels	—	—	—	—	—
3.	Cat fishes	40	—	40	4	19
4.	Clupeids					
a)	Wolf herring	100	1	101	43	6
b)	Oil sardine	—	—	—	1	—
c)	Other sardines	15	1	16	55	7

1	2	3	4	5	6	7
d)	Hilsa shad	—	—	—	—	—
e)	Other shads	7	—	7	2	—
f)	Anchovies					
	Coilia	—	—	—	—	—
	Setipinna	—	—	—	—	—
	Stolephorus	89	—	89	119	268
	Thrissina	—	—	—	—	—
	Thryssa	1,597	—	1,597	939	3,461
g)	Other clupeids	820	—	820	323	97
5.	Bombay duck	—	—	—	—	—
6.	Lizard fishes	50	—	50	20	11
7.	Half beaks & Full beaks	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—
9.	Perches					
a)	Rock cods	145	1	146	15	—
b)	Snappers	11	—	11	1	—
c)	Pig-face breams	9	—	9	9	—
d)	Threadfin breams	446	—	446	109	38
e)	Other perches	13	—	13	25	327
10.	Goat fishes	7	—	7	8	11
11.	Threadfins	1	—	1	1	1
12.	Croakers	753	—	753	438	420
13.	Ribbon fishes	35	—	35	4	—
14.	Carangids					
a)	Horse mackerel	—	—	—	—	—
b)	Scads	—	—	—	—	—
c)	Leather-jackets	5	—	5	5	—
d)	Other carangids	104	—	104	788	944
15.	Silver bellies	2,164	—	2,144	2,783	4,672
16.	Big-jawed jumper	61	2	63	10	—
17.	Pomfrets					
a)	Black pomfret	—	—	—	7	11
b)	Silver pomfret	2	—	2	—	—
c)	Chinese pomfret	—	—	—	—	—
18.	Mackerels					
a)	Indian mackerel	—	2	2	2	—
b)	Other mackerels	—	—	—	—	—
19.	Seer fishes	1	2	3		
a)	*S. commerson*	—	—	—	—	2
b)	*S. guttatus*	—	—	—	189	2
c)	*S. lineolatus*	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—
20.	Tunnies					
a)	*E. affinis*	—	—	—	—	—
b)	*Auxis* spp.	—	—	—	—	—
c)	*K. pelamis*	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—
e)	Other tunnies	—	—	—	—	—
21.	Bill fishes	—	—	—	—	—
22.	Barracudas	61	1	62	126	30
23.	Mullets	—	—	—	—	—

1	2	3	4	5	6	7
24.	Unicorn cod	—	—	—	—	—
25.	Flat fishes					
a)	Halibut	—	—	—	—	—
b)	Flounders	—	—	—	—	—
c)	Soles	44	—	44	4	—
26.	Crustaceans					
a)	Penaeid prawns	730	—	730	1,014	2,061
b)	Non-penaeid prawns	—	—	—	—	—
c)	Lobsters	11	—	11	—	—
d)	Crabs	16	—	16	—	5
e)	Stomatopods	12	—	12	—	—
27.	Cephalopods	10	—	10	5	1
28.	Miscellaneous	1,209	1	1,210	5,714	3,086
	TOTAL	9,441	11	9,452	13,090	15,491

Table 7 (i). *Composition of marine fish landings from mechanised boats at Sakthikulangara during* 1982–'83, 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1982–'83			1983–'84				1984–'85		
		Trawl net	Gill net	Total	Trawl net	Gill net	Hooks & lines	Total	Trawl net	Gill net	Total
1	2	3	4	5	6	7	8	9	10	11	12
1.	Elasmobranchs										
a)	Sharks	13	602	615	37	591	—	628	89	629	718
b)	Skates	1	8	9	—	12	—	12	—	6	6
c)	Rays	451	16	467	151	33	—	184	410	38	448
2.	Eels	11	—	11	—	—	—	—	—	—	—
3.	Cat fishes	2,588	270	2,858	2,094	413	—	2,507	1,779	662	2,441
4.	Clupeids										
a)	Wolf herring	—	—	—	—	1	—	1	10	—	10
b)	Oil sardine	762	2	764	1,836	15	—	1,851	187	—	187
c)	Other sardines	—	—	—	—	—	—	—	—	—	—
d)	Hilsa shad	—	—	—	—	—	—	—	—	—	—
e)	Other shads	—	—	—	—	—	—	—	—	—	—
f)	Anchovies										
	Coilia	—	—	—	—	—	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—	—	—
	Stolephorus	680	—	680	130	—	—	130	462	—	462
	Thryssina	—	—	—	—	—	—	—	—	—	—
	Thryssa	—	—	—	—	—	—	—	2	—	2
g)	Other clupeids	—	—	—	—	—	—	—	—	—	—
5.	Bombay duck	—	—	—	—	—	—	—	—	—	—
6.	Lizard fishes	4,732	—	4,732	4,689	—	—	4,689	6,433	—	6,433
7.	Half beaks & Full beaks	—	3	3	—	6	—	6	—	19	19
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
a)	Rock cod	—	—	—	—	—	254	254	—	2	2
b)	Snappers	1	2	3	—	3	—	3	—	—	—

1	2	3	4	5	6	7	8	9	10	11	12
c)	Pig-face breams	—	—	—	—	—	—	—	—	—	—
d)	Threadfin breams	4,832	—	4,832	5,887	—	—	5,887	15,626	—	15,626
e)	Other perches	369	—	369	693	1	—	694	1,625	—	1,625
10.	Goat fishes	—	—	—	—	—	—	—	1	—	1
11.	Threadfins	—	—	—	—	—	—	—	—	—	—
12.	Croakers	1,325	8	1,333	2,554	6	—	2,560	3,729	6	3,735
13.	Ribbon fishes	54	23	77	15	—	—	15	25	6	31
14.	Carangids										
a)	Horse mackerel	—	—	—	—	—	—	—	—	—	—
b)	Scads	22	3	25	66	5	—	71	316	23	339
c)	Leather-jackets	—	19	19	—	44	—	44	—	30	30
d)	Other carangids	16	69	85	116	97	—	213	96	118	214
15.	Silver bellies	702	—	702	583	—	—	583	466	—	466
16.	Big-jawed jumper	28	—	28	—	—	—	—	44	—	44
17.	Pomfrets										
a)	Black pomfret	—	64	64	—	85	—	85	—	105	105
b)	Silver pomfret	—	3	3	7	19	—	26	—	3	3
c)	Chinese pomfret	—	—	—	—	—	—	—	—	—	—
18.	Mackerels										
a)	Indian mackerel	6	70	76	—	126	—	126	5	294	299
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes										
a)	*S. commerson*	—	38	38	—	276	—	276	—	794	794
b)	*S. guttatus*	—	167	167	—	30	—	30	—	26	26
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—
20.	Tunnies										
a)	*E. affinis*	—	329	329	—	1,025	5	1,030	—	789	789
b)	*Auxis* spp.	—	1	1	—	7	—	7	—	1	1
c)	*K. pelamis*	—	—	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	—	—	—
e)	Other tunnies	—	—	—	—	2	—	2	—	5	5
21.	Bill fishes	—	17	17	—	29	—	29	—	66	66
22.	Barracudas	37	—	37	56	4	—	60	24	3	27
23.	Mullets	—	—	—	—	—	—	—	—	—	—
24.	Unicorn cod	—	—	—	—	—	—	—	—	—	—
25.	Flat fishes										
a)	Halibut	28	—	28	10	—	—	10	7	7	7
b)	Flounders	—	—	—	31	—	—	31	—	—	—
c)	Soles	1,978	—	1,978	2,504	—	—	2,504	3,774	—	3,774
26.	Crustaceans										
a)	Penaeid prawns	9,425	—	9,425	8,175	—	—	8,175	14,577	—	14,577
b)	Non-penaeid prawns	—	—	—	—	—	—	—	—	—	—
c)	Lobsters	11	—	11	13	—	—	13	23	—	23
d)	Crabs	33	—	33	30	—	—	30	62	—	62
e)	Stomatopods	2,068	—	2,068	1,297	—	—	1,297	1,925	—	1,925
27.	Cephalopods	1,289	—	1,289	806	—	—	806	3,514	19	3,533
28.	Miscellaneous	2,443	13	2,456	2,831	22	—	2,853	3,462	148	3,610
	TOTAL	33,905	1,727	35,632	34,611	2,852	259	37,722	58,673	3,792	62,465

Table 7 (j). *Composition of marine fish landings from mechanised boats at Cochin Fisheries Harbour during* 1982–'83 , 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1982–'83					1983–'84						1984–'85					
		Trawl net	Drift/ Gill net	Purse seine	Hooks & lines	Total	Trawl net	Drift/ Gill net	Purse seine	Hooks & lines	Thangu vala (OBE)	Total	Trawl net	Drift/ Gill net	Purse seine	Hooks & lines	Thangu vala (OBE)	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1.	Elasmobranchs																	
a)	Sharks	9	454	—	—	463	9	446	7	7	—	469	3	341	—	5	1	350
b)	Skates	1	2	—	—	3	—	—	—	—	—	—	—	—	—	—	—	—
c)	Rays	47	39	—	—	86	60	12	—	—	—	72	46	8	5	—	1	60
2.	Eels	—	3	—	—	3	—	1	—	—	—	1	1	—	—	—	—	1
3.	Cat fishes	280	361	87	1	729	353	257	84	—	—	694	889	476	319	—	1	1,685
4.	Clupeids																	
a)	Wolf herring	4	1	—	—	5	4	3	—	—	—	7	2	5	—	—	—	7
b)	Oil sardine	262	—	6,285	—	6,547	333	—	11,621	—	65	12,019	51	—	12,029	—	31	12,111
c)	Other sardines	—	—	152	—	152	—	—	388	—	—	388	—	—	664	—	—	664
d)	Hilsa shad	1	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
e)	Other shads	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
f)	Anchovies																	
	Coilia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Stolephorus	248	—	260	—	508	592	—	63	—	7	662	36	—	49	—	101	186
	Thrissina	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Thryssa	22	—	—	—	22	51	—	—	—	—	51	10	—	—	—	—	10
g)	Other clupeids	4	—	31	—	35	8	—	115	—	—	123	—	—	3	—	7	10
5.	Bombay duck	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6.	Lizard fishes	343	—	—	—	343	172	—	—	—	—	172	342	—	—	—	—	342
7.	Half beaks & Full beaks	—	—	—	—	—	—	4	—	—	—	4	—	15	—	—	—	15
8.	Flying fishes	—	4	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—
9.	Perches																	
a)	Rock cods	—	9	—	10	19	—	20	—	13	—	33	11	26	—	42	1	80
b)	Snappers	—	—	—	4	4	6	7	—	6	—	19	—	14	—	14	1	29
c)	Pig-face breams	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
d)	Threadfin breams	3,268	—	—	—	3,268	1,029	—	1	—	—	1,030	5,348	—	—	—	—	5,348
e)	Other perches	157	4	6	—	167	210	2	—	—	—	212	198	2	1	—	—	201
10.	Goat fishes	2	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—
11.	Threadfins	—	4	3	—	7	—	—	6	—	—	6	—	—	—	—	—	—
12.	Croakers	394	—	2	—	396	445	—	11	—	—	456	543	—	28	—	—	571
13.	Ribbon fishes	77	1	2	—	80	12	—	—	—	—	12	8	—	—	—	—	8
14.	Carangids																	
a)	Horse mackerel	—	—	—	—	—	—	—	1	—	—	1	—	3	—	—	—	3
b)	Scads	—	—	1	—	1	32	1	—	—	—	33	19	13	485	—	—	517
c)	Leather-jackets	—	93	10	—	103	—	147	2	—	—	149	—	13	1	—	—	14
d)	Other carangids	54	86	79	—	219	105	50	385	—	—	540	99	90	267	—	—	456
15.	Silver bellies	72	—	4	—	76	98	—	—	—	—	98	37	—	—	—	5	42
16.	Big-jawed jumper	46	—	—	—	46	29	—	—	—	—	29	19	—	—	—	—	19
17.	Pomfrets																	
a)	Black pomfret	—	98	204	—	302	—	89	170	—	—	259	—	87	58	—	—	145
b)	Silver pomfret	14	18	—	—	32	22	15	—	—	—	37	—	7	31	—	—	38
c)	Chinese pomfret	1	7	—	—	8	—	—	—	—	—	—	—	—	—	—	—	—

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
18.	Mackerels																	
a)	Indian mackerel	2	46	1,901	—	1,949	22	28	1,328	—	—	1,378	11	82	2,825	—	—	2,918
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes																	
a)	*S. commerson*	—	280	—	—	280	—	432	—	—	—	432	—	630	1	—	1	632
b)	*S. guttatus*	—	46	1	—	47	—	5	—	—	—	5	—	23	—	—	—	23
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20.	Tunnies																	
a)	*E. affinis*	—	401	43	—	444	—	545	—	—	—	545	2	694	5	—	—	701
b)	*Auxis* spp.	—	294	—	—	294	—	114	—	—	—	114	—	136	—	—	—	136
c)	*K. pelamis*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	7	—	—	7	—	4	—	—	—	4	—	26	—	—	—	26
e)	Other tunnies	—	5	—	—	5	—	11	—	—	—	11	—	25	—	—	—	25
21.	Bill fishes	—	12	—	—	12	—	7	—	—	—	7	—	25	—	—	—	25
22.	Barracudas	30	9	1	—	40	32	1	—	—	—	33	124	6	9	—	—	139
23.	Mullets	—	—	22	—	22	—	—	—	—	—	—	—	—	18	—	—	18
24.	Unicorn cod	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25.	Flat fishes																	
a)	Halibut	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	2
b)	Flounders	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
c)	Soles	339	—	—	—	339	577	—	—	—	—	577	421	—	—	—	—	421
26.	Crustaceans																	
a)	Penaeid prawns	2,957	—	289	—	3,246	3,977	—	45	—	—	4,022	2,357	—	28	—	—	2,385
b)	Non–penaeid prawns	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
c)	Lobsters	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1
d)	Crabs	73	—	—	—	73	119	—	—	—	—	119	72	—	—	—	—	72
e)	Stomatopods	326	—	—	—	326	419	—	—	—	—	419	191	—	—	—	—	191
27.	Cephalopods	140	—	—	—	140	48	—	—	—	—	48	116	1	—	—	—	117
28.	Miscellaneous	111	3	—	—	114	101	18	—	—	—	119	71	13	—	—	—	84
	TOTAL	9,284	2,287	9,383	15	20,969	8,865	2,219	14,227	26	72	25,409	11,030	2,761	16,826	61	150	30,828

Table 7 (k). *Composition of marine fish landings from mechanised boats at Mangalore during* 1983–'84 *and* 1984–'85. *(figures in tonnes)*

Sl. No.	Name of fish	1983–'84 Trawl net	Gill net	Purse seine	Total	1984–'85 Trawl net	Gill net	Purse seine	Total
1	2	3	4	5	6	7	8	9	10
1.	Elasmobranchs								
a)	Sharks	62	77	15	154	5	16	—	21
b)	Skates	—	—	—	—	—	—	—	—
c)	Rays	28	—	—	28	2	—	—	2
2.	Eels	—	—	—	—	—	—	—	—
3.	Cat fishes	559	48	1,101	1,708	36	7	32	75
4.	Clupeids								
a)	Wolf herring	9	2	—	11	—	2	1	3
b)	Oil sardine	—	—	8,673	8,673	—	—	13,661	13,661
c)	Other sardines	—	—	1,892	1,892	—	—	867	867
d)	Hilsa shad	—	—	—	—	—	—	—	—
e)	Other shads	11	—	—	11	—	—	—	—
f)	Anchovies	17		24	41				
	Coilia	—	—	—	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—
	Stolephorus	71	—	4,173	4,244	31	—	3,973	4,004
	Thrissina	—	—	—	—	—	—	—	—
	Thryssa	22	—	177	199	53	—	127	180
g)	Other clupeids	72	—	197	269	7	—	3,637	3,644
5.	Bombay duck	—	—	—	—	—	—	—	—
6.	Lizard fishes	643	—	—	643	112	—	—	112
7.	Half beaks & Full beaks	—	—	—	—	—	1	—	1
8.	Flying fishes	—	—	—	—	—	—	—	—
9.	Perches								
a)	Rock cods	—	—	1	1	—	—	—	—
b)	Snappers	58	—	—	58	—	—	—	—
c)	Pig-face breams	—	—	—	—	19	—	—	19
d)	Threadfin breams	1,264	—	19	1,283	309	—	—	309
e)	Other perches	236	6	—	242	302	—	—	302
10.	Goat fishes	—	—	—	—	—	—	—	—
11.	Threadfins	—	—	—	—	—	—	—	—
12.	Croakers	355	—	349	704	252	—	3	255
13.	Ribbon fishes	147	—	—	147	155	—	—	155
14.	Carangids								
a)	Horse mackerel	—	—	85	85	—	—	—	—
b)	Scads	—	—	—	—	—	—	463	463
c)	Leather-jackets	—	—	—	—	—	—	—	—
d)	Other carangids	321	1	378	700	140	—	161	301

1	2	3	4	5	6	7	8	9	10
15.	Silver bellies	210	—	99	309	98	—	23	121
16.	Big-jawed jumper	127	—	—	127	32	—	—	32
17.	Pomfrets								
a)	Black pomfret	2	5	—	7	—	10	23	33
b)	Silver pomfret	71	2	—	73	11	4	1	16
c)	Chinese pomfret	—	—	—	—	—	—	—	—
18.	Mackerels								
a)	Indian mackerel	1	—	1,053	1,054	—	1	3,933	3,934
b)	Other mackerels	—	—	—	—	—	—	—	—
19.	Seer fishes						80		80
a)	*S. commerson*	7	131	4	142	—	105	—	105
b)	*S. guttatus*	—	28	—	28	—	8	—	8
c)	*S. lineolatus*	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—
20.	Tunnies								
a)	*E. affinis*	—	38	73	111	—	1	3	4
b)	*Auxis* spp.	—	—	—	—	—	1	—	1
c)	*K. pelamis*	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	11	—	11
e)	Other tunnies	—	—	—	—	—	9	—	9
21.	Bill fishes	—	—	—	—	—	—	—	—
22.	Barracudas	25	—	13	38	—	—	—	—
23.	Mullets	—	—	8	8	—	—	20	20
24.	Unicorn cod	—	—	—	—	—	—	—	—
25.	Flat fishes								
a)	Halibut	—	—	—	—	—	—	—	—
b)	Flounders	—	—	—	—	—	—	—	—
c)	Soles	732	—	2	734	992	—	45	1,037
26.	Crustaceans								
a)	Penaeid prawns	1,283	—	604	1,887	1,011	—	123	1,134
b)	Non-penaeid prawns	—	—	—	—	—	—	—	—
c)	Lobsters	—	—	—	—	—	—	—	—
d)	Crabs	226	—	—	226	32	—	—	32
e)	Stomatopods	1,884	—	—	1,884	1,503	—	—	1,503
27.	Cephalopods	175	—	—	175	145	—	—	145
28.	Miscellaneous	577	3	—	580	117	—	—	117
	TOTAL	9,195	341	18,940	28,476	5,364	256	27,096	32,716
	No. of operations of fishing units	38,893	2,830	9,644		21,522	2,584	10,391	

Table 7 (I). *Composition of marine fish landings from mechanised boats at New Ferry Wharf, Bombay during* 1982–'83, 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1982–'83			1983–'84			1984–'85			
		Trawl net	Dol net	Total	Trawl net	Dol net	Total	Trawl net	Dol net	Gill net	Total
1	2	3	4	5	6	7	8	9	10	11	12
1.	Elasmobranchs										
a)	Sharks	1,120	—	1,120	1,380	—	1,380	920	—	9	929
b)	Skates	1,508	—	1,508	2,142	—	2,142	861	—	—	861
c)	Rays	1,854	—	1,854	2,193	—	2,193	951	—	1	952
2.	Eels	3,466	—	3,466	2,115	—	2,115	2,552	—	—	2,552
3.	Cat fishes	1,784	2	1,786	2,069	2	2,071	1,247	2	2	1,251
4.	Clupeids										
a)	Wolf herring	505	—	505	396	—	396	352	—	—	352
b)	Oil sardine	—	—	—	—	—	—	14	—	—	14
c)	Other sardines	—	—	—	—	—	—	1	—	—	1
d)	Hilsa shad	—	—	—	—	—	—	—	—	—	—
e)	Other shads	—	—	—	3	—	3	50	—	3	53
f)	Anchovies										
	Coilia	394	2	396	836	16	852	1,556	13	—	1,569
	Setipinna	—	—	—	—	—	—	—	—	—	—
	Stolephorus	—	15	15	—	22	22	—	48	—	48
	Thrissina	—	—	—	—	—	—	—	—	—	—
	Thryssa	122	—	122	6	2	8	22	—	—	22
g)	Other clupeids	570	2	572	478	32	510	209	4	—	213
5.	Bombay duck	200	5	205	404	20	424	712	2	—	714
6.	Lizard fishes	279	—	279	676	—	676	642	—	—	642
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
a)	Rock cods	131	—	131	15	—	15	62	—	—	62
b)	Snappers	5	—	5	377	—	377	258	—	—	258
c)	Pig-face breams	—	—	—	—	—	—	—	—	—	—
d)	Threadfin breams	1,601	—	1.061	1,567	—	1,567	1,258	—	—	1,258
e)	Other perches	1,006	—	1,006	673	—	673	172	15	—	187
10.	Goat fishes	644	—	644	792	—	792	448	—	—	448
11.	Threadfins	45	—	45	83	—	83	214	—	—	214
12.	Croakers	4,221	—	4,221	4,447	4	4,451	4,728	10	—	4,738
13.	Ribbon fishes	1,622	—	1,622	1,669	4	1,673	1,547	2	—	1,549
14.	Carangids										
a)	Horse mackerel	—	—	—	151	—	151	63	—	—	63
b)	Scads	—	—	—	—	—	—	—	—	—	—
c)	Leather-jackets	129	—	129	112	—	112	119	—	—	119
d)	Other carangids	895	—	895	953	—	953	300	—	1	301

1	2	3	4	5	6	7	8	9	10	11	12
15.	Silver bellies	—	—	—	—	—	—	—	—	—	—
16.	Big-jawed jumper	711	—	711	651	—	651	164	—	—	164
17.	Pomfrets										
a)	Black pomfret	131	—	131	73	—	73	27	—	2	29
b)	Silver pomfret	220	—	220	234	—	234	290	—	2	292
c)	Chinese pomfret	—	—	—	—	—	—	—	—	—	—
18.	Mackerels										
a)	Indian mackerel	51	—	51	220	—	220	152	—	—	152
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes										
a)	*S. commerson*	529	—	529	412	—	412	733	—	24	757
b)	*S. guttatus*	—	—	—	239	—	239	93	—	—	93
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—
20.	Tunnies										
a)	*E. affinis*	—	—	—	756	—	756	313	—	30	343
b)	*Auxis* spp.	—	—	—	870	—	870	—	—	—	—
c)	*K. pelamis*	—	—	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	—	—	—
e)	Other tunnies	1,257	—	1,257	151	—	151	111	—	1	112
21.	Bill fishes	—	—	—	—	—	—	—	—	1	1
22.	Barracudas	—	—	—	—	—	—	—	—	—	—
23.	Mullets	—	—	—	—	—	—	—	—	—	—
24.	Unicorn cod	—	—	—	—	2	2	—	—	—	—
25.	Flat fishes										
a)	Halibut	477	—	477	565	—	565	395	—	—	395
b)	Flounders	—	—	—	—	—	—	—	—	—	—
c)	Soles	184	—	184	327	—	327	474	—	—	474
26.	Crustaceans										
a)	Penaeid prawns	8,886	1	8,887	9,808	13	9,821	12,501	45	—	12,546
b)	Non-penaeid prawns	9	35	44	133	108	241	458	151	—	609
c)	Lobsters	211	—	211	144	—	144	318	—	—	318
d)	Crabs	—	—	—	122	4	126	224	1	—	225
e)	Stomatopods	164	1	165	—	—	—	—	—	—	—
27.	Cephalopods	2,473	—	2,473	3,149	—	3,149	2,331	—	—	2,331
28.	Miscellaneous	674	14	688	654	27	681	813	25	1	839
	TOTAL	37,538	77	37,615	42,045	256	42,301	38,655	319	77	39,051
	No. of operations of fishing units	22,047	533	—	25,309	1,751	—	23,321	1,698	147	—

Table 7 (m). *Composition of marine fish landings from mechanised boats at Sassoon Docks, Bombay during* 1982–'83, 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1982–'83					1983–'84					1984–'85				
		Trawl net	Dol net	Gill net	Hooks & lines	Total	Trawl net	Dol net	Gill net	Hooks & lines	Total	Trawl net	Dol net	Gill net	Hooks & lines	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	Elasmobranchs															
	a) Sharks	1,020	3	212	70	1,305	857	—	208	68	1,133	1,139	2	223	90	1,454
	b) Skates	306	—	38	—	344	161	—	12	1	174	171	—	33	—	204
	c) Rays	444	—	72	4	520	270	—	62	3	335	329	—	74	15	418
2.	Eels	154	—	35	132	321	34	—	4	60	98	36	—	1	92	129
3.	Cat fishes	3,231	7	212	134	3,584	1,546	—	213	170	1,929	1,619	—	221	134	1,974
4.	Clupeids															
	a) Wolf herring	322	7	95	—	424	257	25	136	—	418	262	6	108	—	376
	b) Oil sardine	87	—	—	—	87	—	—	—	—	—	18	20	—	—	38
	c) Other sardines	49	1	—	—	50	7	2	—	—	9	6	3	10	—	19
	d) Hilsa shad	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	e) Other shads	151	—	149	—	300	35	—	70	—	105	36		65	—	101
	f) Anchovies															
	Coilia	757	68	—	—	825	717	71	—	—	788	435	49	—	—	484
	Setipinna	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Stolephorus	—	—	—	—	—	—	63	—	—	63	—	16	—	—	16
	Thrissina	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Thryssa	386	17	1	—	404	222	19	—	—	241	327	23	—	—	350
	g) Other clupeids	236	36	47	—	319	289	26	60	—	335	301	17	75	—	397
5.	Bombay duck	3	220	—	—	223	129	204	—	—	333	27	510	—	—	537
6.	Lizard fishes	616	—	—	—	616	506	—	—	—	506	647	—	—	—	647
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9.	Perches															
	a) Rock cods	54	—	—	—	54	17	—	—	—	17	31	—	1	—	32
	b) Snappers	—	—	—	—	—	—	—	—	5	5	70	—	11	5	86
	c) Pig-face breams	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	d) Threadfin breams	3,139	1	—	—	3,140	1,713	—	—	—	1,713	1,831	—	—	—	1,831
	e) Other perches	378	—	3	2	383	119	—	5	11	135	55	—	6	17	78
10.	Goat fishes	744	—	—	—	744	301	—	—	—	301	328	—	—	—	328
11.	Threadfins	335	—	28	7	370	275	—	4	1	280	49	—	—	—	49
12.	Croakers	2,576	30	176	50	2,823	1,761	25	58	30	1,874	2,075	45	52	47	2,219
13.	Ribbon fishes	2,074	71	—	—	2,145	785	36	—	—	821	1,074	74	6	—	1,154
14.	Carangids															
	a) Horse mackerel	9	—	34	—	43	—	—	23	—	23	2	—	43	—	45
	b) Scads	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	c) Leather–jackets	9	—	30	—	39	1	—	31	—	32	1	—	40	—	41
	d) Other carangids	361	3	7	—	371	188	5	—	—	193	179	—	—	—	179
15.	Silver bellies	9	—	—	—	9	3	—	—	—	3	—	—	—	—	—
16.	Big –jawed jumper	522	—	2	—	524	344	—	—	—	344	127	—	—	—	127
17.	Pomfrets															
	a) Black pomfret	44	3	244	—	291	1	—	104	—	105	10	—	133	—	143
	b) Silver pomfret	718	48	215	—	981	437	48	160	—	645	320	48	140	—	508
	c) Chinese pomfret	1	12	—	—	13	—	—	—	—	—	—	—	—	—	—

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
18.	Mackerels															
a)	Indian mackerel	13	—	4	—	17	—	—	—	—	—	26	—	14	—	40
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes															
a)	*S. commerson*	130	—	173	—	303	13	—	75	—	88	112	—	92	—	204
b)	*S. guttatus*	84	—	48	—	132	165	5	170	—	340	193	2	93	1	289
20.	Tunnies															
a)	*E. affinis*	—	—	—	—	—	14	—	233	—	247	7	—	410	—	417
b)	*Auxis* spp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
c)	*K. pelamis*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
e)	Other tunnies	95	—	314	—	409	—	—	11	—	11	—	—	—	—	—
21.	Bill fishes	—	—	113	—	113	2	—	82	—	84	—	—	99	1	100
22.	Barracudas	79	—	—	—	79	59	—	—	—	59	191	—	—	—	191
23.	Mullets	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24.	Unicorn cod	—	—	—	—	—	—	1	—	—	1	—	—	—	—	—
25.	Flat fishes															
a)	Halibut	122	—	—	—	122	52	—	1	—	53	66	—	10	—	76
b)	Flounders	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
c)	Soles	416	—	—	—	416	202	—	—	—	202	160	—	—	—	160
26.	Crustaceans															
a)	Penaeid prawns	12,829	168	—	—	12,997	12,078	339	—	—	12,417	17,629	195	—	—	17,824
b)	Non-penaeid prawns	185	1,144	—	—	1,329	239	1,077	—	—	1,316	97	937	—	—	1,034
c)	Lobsters	295	1	4	—	300	196	—	—	—	196	327	—	—	—	327
d)	Crabs	83	—	—	—	83	91	—	—	—	91	75	—	—	—	75
e)	Stomatopods	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
27.	Cephalopods	1,989	2	—	—	1,991	2,123	1	—	—	2,124	4,953	—	—	—	4,953
28.	Miscellaneous	634	69	48	6	757	394	54	41	5	494	484	57	37	9	587
	TOTAL	35,689	1,911	2,295	405	40,300	26,603	2,001	1,763	354	30,721	35,825	2,004	1,997	411	40,237
	No. of operations of fishing units	23,305	13,112	3,502	1,705	—	21,928	14,490	3,916	1,518	—	22,753	14,430	3,711	1,620	42,514

Table 7 (n). *Composition of marine fish landings from mechanised boats at Veraval during* 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1983–'84 Trawl net	1983–'84 Gill net	1983–'84 Total	1984–'85 Trawl net	1984–'85 Gill net	1984–'85 Total
1	2	3	4	5	6	7	8
1.	Elasmobranchs						
a)	Sharks	213	169	382	237	539	776
b)	Skates	154	—	154	322	—	322
c)	Rays	589	107	696	415	35	450
2.	Eels	988	—	988	936	2	938
3.	Cat fishes	444	112	556	322	213	553
4.	Clupeids						
a)	Wolf herring	300	266	566	198	312	510
b)	Oil sardine	—	—	—	—	—	—
c)	Other sardines	—	59	59	—	10	10
d)	Hilsa shad	—	69	69	—	27	27
e)	Other shads	—	347	347	—	820	820
f)	Anchovies						
	Coilia	691	—	691	368	—	368
	Setipinna	—	—	—	—	—	—
	Stolephorus	—	—	—	—	—	—
	Thrissina	—	—	—	—	—	—
	Thryssa	1,202	24	1,226	566	7	573
g)	Other clupeids	274	125	399	581	241	822
5.	Bombay duck	164	4	168	82	—	82
6.	Lizard fishes	1,322	—	1,322	622	6	628
7.	Half beaks & Full beaks	—	3	3	—	15	15
8.	Flying fishes	—	—	—	—	—	—
9.	Perches						
a)	Rock cods	408	—	408	364	1	365
b)	Snappers	540	2	542	204	4	208
c)	Pig-face breams	—	—	—	101	—	101
d)	Threadfin breams	1,090	4	1,094	2,400	—	2,400
e)	Other perches	1,641	—	1,641	1,108	2	1,110
10.	Goat fishes	699	—	699	299	—	299
11.	Thread fins	677	7	684	702	41	743
12.	Croakers	7,504	67	7,571	9,191	222	9,413
13.	Ribbon fishes	2,160	122	2,282	2,488	258	2,746
14.	Carangids						
a)	Horse mackerel	2	71	73	46	146	192
b)	Scads	39	31	70	—	—	—
c)	Leather-jackets	11	9	20	6	53	59
d)	Other carangids	79	3	82	188	49	237
15.	Silver bellies	329	—	329	457	—	457
16.	Big-jawed jumper	4,750	—	4,750	2,649	—	2,649
17.	Pomfrets						
a)	Black pomfret	31	76	107	180	132	312
b)	Silver pomfret	131	79	210	200	88	288
c)	Chinese pomfret	—	—	—	—	—	—

1	2	3	4	5	6	7	8
18.	Mackerels						
a)	Indian mackerel	—	—	—	30	18	48
b)	Other mackerels	—	—	—	—	—	—
19.	Seer fishes						
a)	*S. commerson*	—	—	—	50	162	212
b)	*S. guttatus*	101	237	338	37	458	495
c)	*S. lineolatus*	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—
20.	Tunnies						
a)	*E. affinis*	—	72	72	8	290	298
b)	*Auxis* spp.	—	—	—	—	5	5
c)	*K. pelamis*	—	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—
e)	Other tunnies	—	—	—	—	29	29
21.	Bill fishes	103	—	103	—	5	5
22.	Barracudas	211	—	211	85	1	86
23.	Mullets	—	—	—	—	—	—
24.	Unicorn cod	—	—	—	—	—	—
25.	Flat fishes						
a)	Halibut	170	3	173	353	23	376
b)	Flounders	—	—	—	—	—	—
c)	Soles	1,049	—	1,049	3,284	—	3,284
26.	Crustaceans						
a)	Penaeid prawns	1,378	—	1,378	3,091	—	3,091
b)	Non-penaeid prawns	435	—	435	891	—	891
c)	Lobsters	139	1	140	287	—	287
d)	Crabs	2,327	—	2,327	5,151	—	5,151
e)	Stomatopods	474	—	474	981	—	981
27.	Cephalopods	2,276	—	2,276	1,673	—	2,673
28.	Miscellaneous	2,883	26	2,909	4,164	8	4,172
	TOTAL	37,978	2,095	40,073	45,317	4,240	49,557

Table 8 (a). *Composition of marine fish landings from mechanised boats at Visakhapatnam Outer Harbour during 1983–'84 and 1984–'85 (figures in tonnes)*

Sl. No.	Name of fish	1983–'84					1984–'85				
		Apr. to Jun. '83	Jul. to Sep. '83	Oct. to Dec. '83	Jan. to Mar. '84	Total	Apr. to Jun. '84	Jul. to Sep. '84	Oct. to Dec. '84	Jan. to Mar. '85	Total
1	2	3	4	5	6	7	8	9	10	11	12
1.	Elasmobranchs										
a)	Sharks	1	5	4	1	11	8	1	—	—	9
b)	Skates	8	10	12	3	33	6	9	9	3	27
c)	Rays	12	24	23	13	72	44	31	17	5	97
2.	Eels	3	2	19	18	42	20	29	40	12	101
3.	Cat fishes	21	67	14	32	134	14	63	30	19	126
4.	Clupeids										
a)	Wolf herring	—	5	1	1	7	—	4	4	—	8
b)	Oil sardine	—	—	—	—	—	—	—	—	—	—
c)	Other sardines	—	—	—	35	35	1	—	—	—	1

1	2	3	4	5	6	7	8	9	10	11	12
	d) Hilsa shad	—	—	—	—	—	—	—	—	—	—
	e) Other shads	—	—	—	—	—	—	—	—	—	—
	f) Anchovies										
	Coilia	—	—	—	—	—	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—	—	—
	Stolephorus	8	37	96	43	184	2	66	29	—	97
	Thrissina	—	—	—	—	—	—	—	—	—	—
	Thryssa	6	44	5	1	56	24	43	26	1	94
	g) Other clupeids	3	—	—	20	23	9	—	—	3	12
5.	Bombay duck	—	1	1	—	2	1	2	—	—	3
6.	Lizard fishes	93	321	115	60	589	98	251	145	53	547
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
	a) Rock cods	—	—	1	—	1	—	—	—	—	—
	b) Snappers	—	—	—	—	—	—	—	—	—	—
	c) Pig-face breams	—	—	—	—	—	—	—	—	—	—
	d) Threadfin breams	852	102	204	261	1,419	109	157	138	132	536
	e) Other perches	343	254	155	234	986	212	227	100	124	663
10.	Goat fishes	54	135	44	17	250	43	116	102	44	305
11.	Threadfins	1	14	22	7	44	5	22	24	3	54
12.	Croakers	63	117	315	100	595	97	206	215	47	565
13.	Ribbon fishes	8	411	233	21	673	18	374	154	10	556
14.	Carangids										
	a) Horse mackerel	—	2	—	—	2	—	—	—	—	—
	b) Scads	149	12	—	146	307	30	7	—	34	71
	c) Leather-jackets	—	—	—	—	—	—	—	—	—	—
	d) Other carangids	12	35	2	1	50	—	16	9	1	26
15.	Silver bellies	68	248	174	46	536	48	144	78	50	320
16.	Big-jawed jumper	—	81	62	—	143	12	19	20	—	51
17.	Pomfrets										
	a) Black pomfret	—	3	1	—	4	1	2	5	—	8
	b) Silver pomfret	1	1	1	—	3	—	12	21	—	33
	c) Chinese pomfret	—	—	—	—	—	—	—	—	—	—
18.	Mackerels										
	a) Indian mackerel	10	69	11	2	92	1	8	—	1	10
	b) Other mackerels	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes										
	a) *S. commerson*	—	—	—	—	—	—	—	—	—	—
	b) *S. guttatus*	—	1	—	—	1	—	—	—	—	—
	c) *S. lineolatus*	—	—	—	—	—	—	—	—	—	—
	d) *Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—
20.	Tunnies										
	a) *E. affinis*	—	—	—	—	—	—	—	—	—	—
	b) *Auxis* spp.	—	—	—	—	—	—	—	—	—	—
	c) *K. pelamis*	—	—	—	—	—	—	—	—	—	—
	d) *T. tonggol*	—	—	—	—	—	8	—	—	—	8
	e) Other tunnies	—	—	—	—	—	—	—	—	—	—
21.	Bill fishes	—	—	—	—	—	—	—	—	—	—
22.	Barracudas	2	3	—	—	5	—	7	—	—	7
23.	Mullets	—	—	—	—	—	—	—	—	—	—
24.	Unicorn cod	—	—	—	—	—	—	—	—	—	—

1	2	3	4	5	6	7	8	9	10	11	12
25.	Flat fishes										
a)	Halibut	—	—	1	1	2	1	2	5	1	9
b)	Flounders	—	—	—	—	—	—	—	—	—	—
c)	Soles	17	16	15	12	60	45	25	12	6	88
26.	Crustaceans										
a)	Penaeid prawns	77	482	316	233	1,108	187	236	382	85	890
b)	Non-penaeid prawns	6	41	—	2	49	7	38	3	2	50
c)	Lobsters	—	—	—	—	—	—	—	—	—	—
d)	Crabs	109	154	56	83	402	219	152	104	56	531
e)	Stomatopods	5	22	17	36	80	68	80	59	20	227
27.	Cephalopods	81	71	56	31	239	21	78	30	11	140
28.	Miscellaneous	10	15	17	15	57	17	24	19	8	68
	TOTAL	2,023	2,805	1,993	1,475	8,296	1,376	2,451	1,780	731	6,338
	No. of operations of fishing units	7,644	12,541	7,532	5,728	33,445	10,443	11,496	5,432	3,891	31,262

Table 8 (b). *Composition of marine fish landings from mechanised boats at Kakinada Fisheries Harbour during* 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1983–'84					1984–'85				
		Apr. to Jun. 83	Jul. to Sep. '83	Oct. to Dec. ”83	Jan. to Mar. '84	Total	Apr. to Jun. '84	Jul. to Sep. '84	Oct. to Dec. '84	Jan. to Mar. '85	Total
1	2	3	4	5	6	7	8	9	10	11	12
1.	Elasmobranchs										
a)	Sharks	19	16	5	16	56	2	16	6	15	39
b)	Skates	6	4	12	23	45	10	31	13	49	103
c)	Rays	30	73	65	83	251	35	86	41	165	327
2.	Eels	39	64	41	87	231	38	36	35	68	177
3.	Cat fishes	29	57	42	109	237	13	43	73	149	278
4.	Clupeids										
a)	Wolf herring	—	2	—	1	3	—	1	—	—	1
b)	Oil sardine	—	—	—	—	—	—	—	—	—	—
c)	Other sardines	15	2	—	18	35	6	—	1	7	14
d)	Hilsa shad	—	—	—	—	—	—	—	—	—	—
e)	Other shads	—	—	—	—	—	5	3	—	—	8
f)	Anchovies										
	Coilia	—	7	2	—	9	6	7	1	—	14
	Setipinna	—	—	—	—	—	—	—	—	—	—
	Stolephorus	98	140	168	315	721	228	287	202	220	937
	Thrissina	—	—	—	—	—	—	—	—	—	—
	Thryssa	18	107	84	139	348	106	131	101	155	493
g)	Other clupeids	22	23	30	87	162	46	76	16	52	190
5.	Bombay duck	—	70	13	—	83	25	70	2	—	97
6.	Lizard fishes	44	99	72	117	332	15	175	137	121	448
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
a)	Rock cods	—	1	2	—	3	3	3	—	—	6
b)	Snappers	3	2	5	1	11	9	8	5	26	48

1	2	3	4	5	6	7	8	9	10	11	12
c)	Pig-face breams	—	—	—	—	—	—	—	—	—	—
d)	Threadfin breams	145	180	84	643	1,052	17	99	291	300	707
e)	Other perches	143	219	97	1,135	1,594	68	172	157	513	910
10.	Goat fishes	61	42	20	54	177	31	107	45	65	248
11.	Threadfins	2	20	13	30	65	12	24	17	55	108
12.	Croakers	144	355	277	364	1,140	167	291	188	573	1,219
13.	Ribbon fishes	316	684	210	214	1,424	176	454	212	237	1,079
14.	Carangids										
a)	Horse mackerel	—	—	—	—	—	—	—	—	—	—
b)	Scads	45	11	1	1,292	1,349	1	27	33	496	557
c)	Leather-jackets	—	—	—	—	—	—	—	—	—	—
d)	Other carangids	14	113	27	47	201	39	68	47	53	207
15.	Silver bellies	307	762	331	600	2,000	333	414	271	395	1,413
16.	Big-jawed jumper	3	121	33	7	164	7	20	7	12	46
17.	Pomfrets										
a)	Black pomfret	2	3	2	—	7	—	1	—	—	1
b)	Silver pomfret	—	4	1	—	5	2	13	3	8	26
c)	Chinese pomfret	—	—	—	—	—	—	—	—	—	—
18.	Mackerels										
a)	Indian mackerel	5	21	6	9	41	22	5	2	7	36
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes										
a)	*S. commerson*	2	—	—	—	2	—	—	—	—	—
b)	*S. guttatus*	—	2	—	—	2	—	1	—	—	1
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—
20.	Tunnies										
a)	*E. affinis*	—	—	—	—	—	—	—	—	—	—
b)	*Auxis* spp.	—	—	—	—	—	—	—	—	—	—
c)	*K. pelamis*	—	—	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	—	—	—
e)	Other tunnies	—	—	—	—	—	—	—	—	—	—
21.	Bill fishes										
22.	Barracudas	41	20	5	45	111	4	7	13	64	88
23.	Mullets	—	—	1	—	1	—	—	—	—	—
24.	Unicorn cod	—	—	—	—	—	—	—	—	—	—
25.	Flat fishes	—	—	—	—	—	—	—	—	—	—
a)	Halibut	—	4	3	4	11	1	7	6	14	28
b)	Flounders	60	1	7	9	77	1	15	1	16	33
c)	Soles	78	99	69	108	354	37	57	40	102	236
26.	Crustaceans										
a)	Penaeid prawns	376	789	700	1,096	2,961	568	710	414	696	2,388
b)	Non-penaeid prawns	419	1,736	299	1	2,455	127	317	61	25	530
c)	Lobsters	—	—	—	—	—	—	1	2	2	5
d)	Crabs	157	286	123	195	761	112	112	85	146	455
e)	Stomatopods	94	145	64	98	401	81	52	43	74	250
27.	Cephalopods	34	38	42	70	184	19	43	31	47	140
28.	Miscellaneous	106	77	53	91	227	58	81	43	66	248
	TOTAL	2,877	6,399	3,009	7,108	19,393	2,430	4,071	2,645	4,993	14,139
	No. of operations of fishing units	10,194	14,276	8,612	15,181	48,263	9,046	12,014	6,022	9,499	36,581

Table 8 (c). *Composition of marine fish landings from mechanised boats at Pudumanikuppam during* 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1983–'84 Apr. to Jun. '83	Jul. to Sep. '83	Oct. to Dec. '83	Jan. to Mar. '84	Total	1984–'85 Apr. to Jun. '84	Jul. to Sep. '84	Oct. to Dec. '84	Jan. to Mar. '85	Total
1	2	3	4	5	6	7	8	9	10	11	12
1.	Elasmobranchs										
a)	Sharks	2	13	4	4	23	181	156	28	93	458
b)	Skates	2	10	5	7	24	64	15	2	12	93
c)	Rays	24	13	10	7	54	25	38	18	39	120
2.	Eels	—	—	—	—	—	5	—	—	—	5
3.	Cat fishes	4	3	8	2	17	173	99	4	9	285
4.	Clupeids										
a)	Wolf herring	—	—	2	1	3	26	12	1	3	42
b)	Oil sardine	—	—	—	—	—	—	—	—	—	—
c)	Other sardines	—	—	5	4	9	—	—	—	—	—
d)	Hilsa shad	—	—	—	—	—	—	—	—	—	—
e)	Other shads	—	—	—	—	—	—	—	—	—	—
f)	Anchovies										
	Coilia	—	—	—	—	—	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—	—	—
	Stolephorus	20	54	13	—	87	18	55	152	8	233
	Thrissina	—	—	—	—	—	—	—	—	—	—
	Thryssa	3	1	6	7	17	37	—	5	1	43
g)	Other clupeids	2	—	—	14	16	—	—	1	1	2
5.	Bombay duck	—	—	—	—	—	—	—	—	—	—
6.	Lizard fishes	86	137	52	13	288	165	257	390	115	927
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
a)	Rock cods	—	—	—	—	—	73	80	7	42	202
b)	Snappers	—	4	—	—	4	71	39	54	29	193
c)	Pig-face breams	—	—	—	4	4	—	—	—	—	—
d)	Threadfin breams	295	531	121	324	1,271	192	159	262	73	686
e)	Other perches	256	197	60	164	677	86	68	66	53	273
10.	Goat fishes	13	19	26	4	62	30	11	34	24	99
11.	Threadfins	2	5	8	2	17	16	10	4	14	44
12.	Croakers	52	59	207	87	405	121	82	100	32	335
13.	Ribbon fishes	17	54	80	13	164	233	177	164	35	609
14.	Carangids										
a)	Horse mackerel	—	—	—	—	—	—	—	—	—	—
b)	Scads	73	179	27	115	394	29	9	—	14	52
c)	Leather-jackets	2	6	6	1	15	22	—	—	59	81
d)	Other carangids	10	22	3	2	37	156	75	196	77	504

1	2	3	4	5	6	7	8	9	10	11	12
15.	Silver bellies	400	429	384	319	1,532	364	280	382	192	1,218
16.	Big-jawed jumper	—	—	2	—	2	16	33	—	4	53
17.	Pomfrets										
a)	Black pomfret	—	1	—	—	1	17	21	20	9	67
b)	Silver pomfret	4	—	4	2	10	32	38	59	9	138
c)	Chinese pomfret	—	—	—	—	—	—	—	—	—	—
18.	Mackerels										
a)	Indian mackerel	1	58	2	2	63	6	—	—	—	6
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes										
a)	*S. commerson*	15	25	1	5	46	78	90	3	53	224
b)	*S. guttatus*	—	1	—	3	4	42	48	128	46	264
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—
20.	Tunnies										
a)	*E. affinis*	2	5	—	2	9	31	15	80	27	153
b)	*Auxis* spp.	1	—	—	—	1	7	20	13	—	40
c)	*K. pelamis*	13	—	—	—	13	32	2	1	9	44
d)	*T. tonggol*	—	—	—	1	1	—	—	—	—	—
e)	Other tunnies	—	—	—	—	—	—	—	—	—	—
21.	Bill fishes	10	12	—	1	23	19	28	11	19	77
22.	Barracudas	2	42	9	2	55	32	17	58	17	124
23.	Mullets	—	—	—	—	—	—	—	—	—	—
24.	Unicorn cod	—	—	—	—	—	—	—	—	—	—
25.	Flat fishes										
a)	Halibut	—	—	3	—	3	3	—	20	1	24
b)	Flounders	—	—	—	—	—	—	—	—	—	—
c)	Soles	5	8	8	3	24	7	7	9	—	23
26.	Crustaceans										
a)	Penaeid prawns	217	176	216	161	770	156	91	101	62	410
b)	Non-penaeid prawns	—	—	—	—	—	—	—	—	—	—
c)	Lobsters	31	14	11	12	68	36	54	38	2	130
d)	Crabs	44	14	33	43	134	86	45	116	—	247
e)	Stomatopods	2	3	16	14	35	—	—	—	—	—
27.	Cephalopods	70	278	17	53	418	54	37	52	22	165
28.	Miscellaneous	421	432	1,309	446	2,608	144	141	149	107	541
	TOTAL	2,101	2,805	2,658	1,844	9,408	2,885	2,309	2,728	1,312	9,234
	No. of operations of fishing units	8,763	8,677	7,312	5,981	30,733	9,880	10,216	10,441	7,977	38,514

Table 8 (d). *Composition of marine fish landings from mechanised boats at Cuddalore Fisheries Harbour during* 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1983–'84					1984–'85				
		Apr. to Jun. '83	Jul. to Sep. '83	Oct. to Dec. '83	Jan. to Mar. '84	Total	Apr. to Jun. '84	Jul. to Sep. '84	Oct. to Dec. '84	Jan. to Mar. '85	Total
1	2	3	4	5	6	7	8	9	10	11	12
1.	Elasmobranchs										
a)	Sharks	7	36	4	37	84	48	27	2	53	130
b)	Skates	—	—	—	—	—	—	—	—	—	—
c)	Rays	—	—	—	11	11	12	—	—	10	22
2.	Eels	—	—	—	—	—	—	—	—	—	—
3.	Cat fishes	—	—	—	—	—	—	—	—	—	—
4.	Clupeids										
a)	Wolf herring	—	—	—	—	—	—	—	—	—	—
b)	Oil sardine	—	—	—	—	—	—	—	—	—	—
c)	Other sardines	—	—	—	—	—	—	—	—	—	—
d)	Hilsa shad	—	—	—	—	—	—	—	—	—	—
e)	Other shads	—	—	—	—	—	—	—	—	—	—
f)	Anchovies										
	Coilia	—	—	—	—	—	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—	—	—
	Stolephorus	55	112	11	—	178	123	12	2	1	138
	Thrissina	—	—	—	—	—	—	—	—	—	—
	Thryssa	8	—	23	24	55	—	16	—	4	20
g)	Other clupeids	—	48	25	16	89	44	11	21	20	96
5.	Bombay duck	—	—	—	—	—	—	—	—	—	—
6.	Lizard fishes	172	122	34	47	375	121	120	66	19	326
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
a)	Rock cods	—	—	—	—	—	—	—	—	—	—
b)	Snappers	—	—	—	—	—	—	—	—	—	—
c)	Pig-face breams	—	—	—	—	—	—	—	—	—	—
d)	Threadfin breams	153	76	10	17	256	25	69	46	12	152
e)	Other perches	117	31	—	—	148	43	43	11	—	97
10.	Goat fishes	34	—	2	2	38	13	7	13	—	33
11.	Threadfins	—	6	—	—	6					
12.	Croakers	3	14	32	50	99	87	74	55	53	269
13.	Ribbon fishes	—	9	16	2	27	—	—	—	7	7
14.	Carangids										
a)	Horse mackerel	—	—	—	—	—	—	—	—	—	—
b)	Scads	—	—	—	—	—	—	—	—	—	—
c)	Leather-jackets	—	1	—	3	4	—	4	—	4	4
d)	Other carangids	—	9	—	2	11	26	18	—	1	45

1	2	3	4	5	6	7	8	9	10	11	12
15.	Silver bellies	464	414	302	260	1,440	282	267	160	122	831
16.	Big-jawed jumper	—	—	—	—	—	—	—	—	—	—
17.	Pomfrets										
a)	Black pomfret	—	—	—	—	—	—	—	—	—	—
b)	Silver pomfret	—	—	—	—	—	—	—	—	—	—
c)	Chinese pomfret	—	1	—	—	1	—	—	—	—	—
18.	Mackerels										
a)	Indian mackerel	—	4	—	—	4	—	—	—	—	—
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes										
a)	*S. commerson*	13	83	5	35	136	52	19	8	22	101
b)	*S. guttatus*	—	—	—	—	—	—	—	—	—	—
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—
20.	Tunnies										
a)	*E. affinis*	5	19	—	23	47	21	23	2	16	62
b)	*Auxis* spp.	—	—	—	—	—	—	—	—	—	—
c)	*K. pelamis*	19	—	—	—	19	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	—	—	—
e)	Other tunnies	—	—	—	—	—	—	—	—	—	—
21.	Bill fishes	4	—	—	3	7	18	2	3	1	24
22.	Barracudas	—	—	—	5	5	—	—	—	—	—
23.	Mullets	—	—	—	—	—	—	11	—	—	11
24.	Unicorn cod	—	—	—	—	—	—	—	—	—	—
25.	Flat fishes										
a)	Halibut	—	—	—	—	—	—	—	—	—	—
b)	Flounders	—	—	—	—	—	—	—	—	—	—
c)	Soles	5	6	—	—	11	—	1	3	12	16
26.	Crustaceans										
a)	Penaeid prawns	67	40	60	129	296	134	113	42	74	363
b)	Non-penaeid prawns	—	—	—	—	—	—	—	—	—	—
c)	Lobsters	—	—	—	—	—	—	—	—	—	—
d)	Crabs	19	1	37	7	64	26	38	24	14	102
e)	Stomatopods	—	—	7	19	26	—	8	4	—	12
27.	Cephalopods	39	31	10	4	84	6	21	3	1	31
28.	Miscellaneous	53	49	44	27	173	34	34	10	6	84
	TOTAL	1,237	1,112	622	723	3,694	1,115	934	475	452	2,976
	No. of operations of fishing units	3,887	3,126	3,014	2,462	12,489	2,948	2,909	1,870	2,687	10,414

Table 8 (c). *Composition of marine fish landings from mechanised boats at Nagapattinam during 1983–'84 and 1984–'85 (figures in tonnes)*

Sl. No.	Name of fish	1983–'84					1984–'85				
		Apr. to Jun. '83	Jul. to Sep. '83	Oct. to Dec. '83	Jan. to Mar. '84	Total	Apr. to Jun. '84	Jul. to Sep. '84	Oct. to Dec. '84	Jan. to Mar. '85	Total
1	2	3	4	5	6	7	8	9	10	11	12
1.	Elasmobranchs										
a)	Sharks	—	—	—	—	—	17	21	—	3	41
b)	Skates	—	—	—	1	1	—	—	—	—	—
c)	Rays	142	200	112	150	604	100	67	137	57	361
2.	Eels	6	3	6	12	27	—	—	2	3	5
3.	Cat fishes	21	44	75	10	150	82	13	47	—	142
4.	Clupeids										
a)	Wolf herring	2	—	1	6	9	—	—	—	—	—
b)	Oil sardine	—	—	—	—	—	1	—	1	—	2
c)	Other sardines	—	—	4	—	4	2	—	—	—	2
d)	Hilsa shad	—	—	—	—	—	—	—	—	—	—
e)	Other shads	—	—	—	—	—	—	—	—	—	—
f)	Anchovies										
	Coilia	3	90	311	127	531	33	37	156	33	259
	Setipinna	—	—	—	—	—	—	—	—	—	—
	Stolephorus	59	512	14	303	888	120	129	32	57	338
	Thrissina	—	—	—	—	—	—	—	—	—	—
	Thryssa	47	55	115	192	409	129	46	109	57	341
g)	Other clupeids	104	192	160	270	726	214	119	102	76	511
5.	Bombay duck	—	—	—	—	—	—	—	—	—	—
6.	Lizard fishes	81	135	24	28	268	51	132	51	49	283
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
a)	Rock cods	—	—	—	—	—	—	—	—	—	—
b)	Snappers	—	—	—	—	—	—	—	—	—	—
c)	Pig-face breams	—	—	—	—	—	—	—	—	—	—
d)	Threadfin breams	169	255	32	11	467	55	128	109	12	304
e)	Other perches	88	482	29	2	601	14	118	45	45	222
10.	Goat fishes	27	31	12	80	79	15	2	32	9	58
11.	Threadfins	—	—	—	—	—	2	—	4	3	9
12.	Croakers	204	383	495	484	1,566	393	130	439	96	1,058
13.	Ribbon fishes	9	19	65	160	253	44	9	49	8	110
14.	Carangids										
a)	Horse mackerel	—	—	—	—	—	—	—	—	—	—
b)	Scads	—	—	—	—	—	—	—	—	—	—
c)	Leather-jackets	—	—	—	—	—	—	—	—	—	—
d)	Other carangids	78	161	48	41	328	—	4	—	—	4
							77	109	93	14	293

1	2	3	4	5	6	7	8	9	10	11	12
15.	Silver bellies	626	1,289	394	716	3,025	418	407	412	535	1,772
16.	Big-jawed jumper	—	2	1	1	4	7	8	—	2	17
17.	Pomfrets										
a)	Black pomfret	—	11	—	2	13	—	1	—	—	1
b)	Silver pomfret	—	4	22	11	37	17	—	9	11	37
c)	Chinese pomfret	—	—	—	—	—	—	—	—	—	—
18.	Mackerels										
a)	Indian mackerel	—	4	2	2	8	7	—	—	—	7
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes										
a)	*S. commerson*	—	3	—	2	5	—	—	—	1	1
b)	*S. guttatus*	—	—	1	—	1	—	—	—	—	—
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—
20.	Tunnies										
a)	*E. affinis*	—	—	—	—	—	—	—	—	—	—
b)	*Auxis* spp.	—	—	—	—	—	—	—	—	—	—
c)	*K. pelamis*	—	—	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	—	—	—
e)	Other tunnies	—	—	—	—	—	—	—	—	—	—
21.	Bill fishes	—	—	—	—	—	—	—	—	—	—
22.	Barracudas	36	35	12	15	98	20	3	20	17	60
23.	Mullets	—	—	—	—	—	22	—	—	—	22
24.	Unicorn cod	—	—	—	—	—	—	—	—	16	16
25.	Flat fishes										
a)	Halibut	30	59	13	5	107	21	—	36	—	57
b)	Flounders	—	—	—	—	—	26	—	—	—	26
c)	Soles	39	53	69	59	220	54	65	80	21	220
26.	Crustaceans										
a)	Penaeid prawns	161	223	259	900	1,543	367	121	378	207	1,073
b)	Non-penaeid prawns	—	—	—	42	42	85	—	—	37	122
c)	Lobsters	4	8	3	—	15	—	16	5	2	23
d)	Crabs	50	53	179	120	402	183	35	212	20	450
e)	Stomatopods	—	—	1	—	1	—	—	4	—	4
27.	Cephalopods	34	21	3	7	65	9	54	5	18	86
28.	Miscellaneous	52	84	66	155	357	129	190	88	121	528
	TOTAL	2,072	4,411	2,528	3,843	12,854	2,714	1,964	2,657	1,530	8,865
	No. of operations of fishing units	4,406	6,753	5,219	17,069	33,447	10,682	12,499	7,417	10,431	41,029

Table 8 (f). *Composition of marine fish landings from mechanised boats at Mandapam during 1983–'84 and 1984–'85 (figures in tonnes)*

Sl. No.	Name of fish	1983–'84 Apr. to Jun. '83	Jul. to Sep. '83	Oct. to Dec. '83	Jan. to Mar. '84	Total	1984–'85 Apr. to Jun. '84	Jul. to Sep. '84	Oct. to Dec. '84	Jan. to Mar. '85	Total
1	2	3	4	5	6	7	8	9	10	11	12
1.	Elasmobranchs										
a)	Sharks	—	—	—	1	1	—	—	—	—	—
b)	Skates	—	—	—	—	—	—	—	—	—	—
c)	Rays	28	40	74	66	208	173	45	50	64	332
2.	Eels	4	—	—	—	4	—	—	—	—	—
3.	Cat fishes	8	14	15	13	50	26	17	5	12	60
4.	Clupeids										
a)	Wolf herring	2	1	—	2	5	—	—	—	—	—
b)	Oil sardine	10	5	1	11	27	6	—	—	—	6
c)	Other sardines	3	4	12	22	41	21	11	10	22	64
d)	Hilsa shad	2	—	5	1	8	—	—	—	—	—
e)	Other shads	—	3	—	11	14	30	2	—	1	33
f)	Anchovies										
	Coilia	—	—	—	2	2	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—	—	—
	Stolephorus	—	2	—	1	3	2	1	1	—	4
	Thrissina	—	—	—	—	—	—	—	—	—	—
	Thryssa	5	3	3	3	14	7	11	3	2	23
g)	Other clupeids	10	12	12	8	42	7	8	5	11	31
5.	Bombay duck	—	—	—	—	—	—	—	—	—	—
6.	Lizard fishes	1	1	2	2	6	—	—	2	—	2
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
a)	Rock cods	—	—	—	—	—	—	—	—	—	—
b)	Snappers	—	—	—	—	—	—	—	—	—	—
c)	Pig-face breams	7	—	12	4	23	4	2	3	2	11
d)	Threadfin breams	1	—	—	—	1	—	2	—	—	2
e)	Other perches	22	20	41	26	109	53	35	26	32	146
10.	Goat fishes	30	34	26	6	96	27	46	11	19	103
11.	Threadfins	—	—	1	1	2	—	2	—	—	2
12.	Croakers	76	80	102	90	348	104	90	62	92	348
13.	Ribbon fishes	2	—	—	1	3	—	—	3	—	3
14.	Carangids										
a)	Horse mackerel	—	—	—	—	—	—	—	—	—	—
b)	Scads	—	—	—	—	—	—	—	—	—	—
c)	Leather-jackets	1	—	—	—	1	1	1	—	—	2
d)	Other carangids	2	14	13	9	38	18	29	17	14	78

1	2	3	4	5	6	7	8	9	10	11	12
15.	Silver bellies	1,123	793	426	568	2,910	824	609	365	621	2,419
16.	Big-jawed jumper	1	—	—	—	1	—	—	—	1	1
17.	Pomfrets										
a)	Black pomfret	—	—	—	—	—	—	—	—	—	—
b)	Silver pomfret	3	—	2	11	16	—	2	—	2	4
c)	Chinese pomfret	—	—	—	—	—	1	—	—	—	1
18.	Mackerels										
a)	Indian mackerel	—	—	—	—	—	—	1	1	—	2
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes										
a)	*S. commerson*	—	—	—	—	—	—	—	—	—	—
b)	*S. guttatus*	—	—	—	—	—	—	—	—	—	—
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—
20.	Tunnies										
a)	*E. affinis*	—	—	—	—	—	—	—	—	—	—
b)	*Auxis* spp.	—	—	—	—	—	—	—	—	—	—
c)	*K. pelamis*	1	—	—	—	1	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	—	—	—
e)	Other tunnies	—	—	—	—	—	—	—	—	—	—
21.	Bill fishes	—	—	—	—	—	—	—	—	—	—
22.	Barracudas	—	—	—	—	—	—	—	—	—	—
23.	Mullets	—	—	14	—	14	7	1	—	—	8
24.	Unicorn cod	—	—	—	—	—	—	—	—	—	—
25.	Flat fishes										
a)	Halibut	—	—	—	—	—	—	—	—	—	—
b)	Flounders	—	—	—	—	—	—	—	—	—	—
c)	Soles	3	18	14	20	55	13	10	19	18	60
26.	Crustaceans										
a)	Penaeid prawns	226	190	164	214	794	513	243	98	177	1,031
b)	Non-penaeid prawns	—	—	—	2	2	—	—	—	—	—
c)	Lobsters	—	—	—	—	—	—	—	—	—	—
d)	Crabs	62	58	83	69	272	361	190	89	92	732
e)	Stomatopods	—	—	—	—	—	—	—	—	—	—
27.	Cephalopods	29	18	14	26	87	35	33	18	62	148
28.	Miscellaneous	562	507	410	319	1,798	625	389	283	357	1,654
	TOTAL	2,224	1,817	1,446	1,509	6,996	2,858	1,780	1,071	1,601	7,310
	No. of operations of fishing units	12,749	12,314	13,635	15,376	54,074	21,666	14,800	10,574	12,523	59,563

Table 8 (g). *Composition of marine fish landings from mechanised boats at Rameswaram Verkottil during* 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1983–'84 Apr. to Jun. '83	Jul. to Sep. '83	Oct. to Dec. '83	Jan. to Mar. '84	Total	1984–'85 Apr. to Jun. '84	Jul. to Sep. '84	Oct. to Dec. '84	Jan. to Mar. '85	Total
1	2	3	4	5	6	7	8	9	10	11	12
1.	Elasmobranchs										
a)	Sharks	—	—	—	—	—	—	—	—	—	—
b)	Skates	—	—	—	—	—	—	—	—	—	—
c)	Rays	1,082	369	970	828	3,249	786	1,162	554	359	2,861
2.	Eels	—	—	—	—	—	—	—	—	—	—
3.	Cat fishes	17	12	93	103	225	150	89	52	51	342
4.	Clupeids										
a)	Wolf herring	—	—	—	—	—	—	—	—	—	—
b)	Oil sardine	—	17	10	11	38	—	—	—	—	—
c)	Other sardines	29	47	216	95	387	107	198	119	88	512
d)	Hilsa shad	42	—	1	5	48	—	—	—	—	—
e)	Other shads	5	8	9	40	62	50	25	19	133	227
f)	Anchovies										
	Coilia	—	—	—	—	—	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—	—	—
	Stolephorus	—	—	—	—	—	—	3	—	—	3
	Thrissina	—	—	—	—	—	—	—	—	—	—
	Thryssa	—	—	1	11	12	—	—	—	—	—
g)	Other clupeids	2	1	8	79	90	13	—	4	80	97
5.	Bombay duck	—	—	—	—	—	—	—	—	—	—
6.	Lizard fishes	77	75	40	53	245	—	12	18	9	39
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
a)	Rock cods	—	—	—	1	1	—	—	—	—	—
b)	Snappers	—	—	—	—	—	—	—	—	—	—
c)	Pig-face breams	—	—	—	—	—	—	—	—	—	—
d)	Threadfin breams	—	—	1	—	1	—	—	—	1	1
e)	Other perches	68	110	105	48	331	155	199	96	65	515
10.	Goat fishes	148	183	171	105	607	95	143	91	68	397
11.	Threadfins	—	—	—	—	—	73	—	—	—	73
12.	Croakers	1,062	307	564	600	2,533	316	518	399	311	1,544
13.	Ribbon fishes	—	—	—	—	—	—	—	—	—	—
14.	Carangids										
a)	Horse mackerel	—	—	—	—	—	—	—	—	—	—
b)	Scads	—	—	—	—	—	—	—	—	—	—
c)	Leather–jackets	—	—	—	—	—	—	—	—	—	—
d)	Other carangids	13	17	12	18	60	19	79	48	41	187

1	2	3	4	5	6	7	8	9	10	11	12
15.	Silver bellies	4,905	3,421	2,931	2,772	14,029	2,867	3,843	1,787	1,515	10,012
16.	Big-jawed jumper	—	—	4	—	4	—	—	—	—	—
17.	Pomfrets										
a)	Black pomfret	—	—	—	—	—	—	—	—	—	—
b)	Silver pomfret	1	—	—	22	23	—	—	—	5	5
c)	Chinese pomfret	—	—	—	—	—	—	—	—	—	—
18.	Mackerels										
a)	Indian mackerel	1	—	—	—	1	—	1	5	8	14
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes										
a)	*S. commerson*	—	—	—	—	—	—	—	—	—	—
b)	*S. guttatus*	—	—	—	—	—	—	—	—	—	—
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—
20.	Tunnies										
a)	*E. affinis*	—	—	—	—	—	—	—	—	—	—
b)	*Auxis* spp.	—	—	—	—	—	—	—	—	—	—
c)	*K. pelamis*	—	—	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	—	—	—
e)	Other tunnies	—	—	—	—	—	—	—	—	—	—
21.	Bill fishes	—	—	—	—	—	—	—	—	—	—
22.	Barracudas	1	—	—	—	1	—	1	—	—	1
23.	Mullets	—	—	3	—	3	—	—	—	—	—
24.	Unicorn cod	—	—	—	—	—	—	—	—	—	—
25.	Flat fishes										
a)	Halibut	—	—	—	—	—	—	—	—	—	—
b)	Flounders	—	—	—	—	—	—	—	—	—	—
c)	Soles	41	45	49	44	179	37	34	32	23	126
26.	Crustaceans										
a)	Penaeid prawns	954	489	480	506	2,429	1,039	837	295	381	2,552
b)	Non–penaeid prawns	—	—	—	—	—	—	—	—	—	—
c)	Lobsters	—	—	—	—	—	—	—	—	—	—
d)	Crabs	441	370	126	79	1,016	332	374	113	49	868
e)	Stomatopods	—	—	—	30	30	56	86	35	38	215
27.	Cephalopods	87	60	70	45	262	53	44	38	52	187
28.	Miscellaneous	252	405	364	206	1,227	146	224	166	181	717
	TOTAL	9,228	5,936	6,228	5,701	27,093	6,294	7,872	3,871	3,458	21,495
	No. of operations of fishing units	22,999	25,295	27,623	22,143	98,060	23,236	25,434	14,248	12,399	75,317

Table 8 (h). *Composition of marine fish landings from mechanised boats at Tuticorin Fisheries Harbour during* 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1983–'84					1984–'85				
		Apr. to Jun. '83	Jul. to Sep. '83	Oct. to Dec. '83	Jan. to Mar. '84	Total	Apr. to Jun. '84	Jul. to Sep. '84	Oct. to Dec. '84	Jan. to Mar. '85	Total
1	2	3	4	5	6	7	8	9	10	11	12
1.	Elasmobranchs										
a)	Sharks	103	—	16	—	119	—	—	—	—	—
b)	Skates	—	—	—	—	—	—	—	—	—	—
c)	Rays	136	6	54	12	208	10	—	—	1	11
2.	Eels	—	—	—	—	—	—	—	—	—	—
3.	Cat fishes	—	—	1	3	4	—	—	—	19	19
4.	Clupeids										
a)	Wolf herring	15	6	14	8	43	—	—	—	6	6
b)	Oil sardine	1	—	—	—	1	—	—	—	—	—
c)	Other sardines	9	—	—	46	55	—	—	2	5	7
d)	Hilsa shad	—	—	—	—	—	—	—	—	—	—
e)	Other shads	—	—	—	2	2	—	—	—	—	—
f)	Anchovies										
	Coilia	—	—	—	—	—	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—	—	—
	Stolephorus	—	75	44	—	119	48	220	—	—	268
	Thrissina	—	—	—	—	—	—	—	—	—	—
	Thryssa	282	—	138	519	939	760	1,310	1,003	388	3,461
g)	Other clupeids	267	—	56	—	323	85	—	12	—	97
5.	Bombay duck	—	—	—	—	—	—	—	—	—	—
6.	Lizard fishes	—	16	—	4	20	1	—	—	10	11
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
a)	Rock cods	—	—	—	15	15	—	—	—	—	—
b)	Snappers	—	—	—	1	1	—	—	—	—	—
c)	Pig-face breams	—	—	5	4	9	—	—	—	—	—
d)	Threadfin breams	2	47	53	7	109	7	—	—	31	38
e)	Other perches	—	—	1	24	25	309	—	—	18	327
10.	Goat fishes	—	—	4	4	8	1	1	—	9	11
11.	Threadfins	—	—	1	—	1	—	—	—	—	—
12.	Croakers	205	4	82	147	438	352	2	9	57	420
13.	Ribbon fishes	1	—	3	—	4	—	—	—	—	—
14.	Carangids										
a)	Horse mackerel	—	—	—	—	—	—	—	—	—	—
b)	Scads	—	—	—	—	—	—	—	—	—	—
c)	Leather-jackets	—	—	5	—	5	—	—	—	—	—
d)	Other carangids	10	2	31	745	788	261	374	230	79	944

1	2	3	4	5	6	7	8	9	10	11	12
15.	Silver bellies	290	125	1,167	1,201	2,783	1,006	1,403	1,063	1,200	4,672
16.	Big-jawed jumper	2	—	3	5	10	—	—	—	—	—
17.	Pomfrets										
a)	Black pomfret	—	—	2	5	7	—	—	—	11	11
b)	Silver pomfret	—	—	—	—	—	—	—	—	—	—
c)	Chinese pomfret	—	—	—	—	—	—	—	—	—	—
18.	Mackerels										
a)	Indian mackerel	—	—	—	2	2	—	—	—	—	—
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes										
a)	*S. commerson*	—	—	—	—	—	—	—	—	2	2
b)	*S. guttatus*	—	—	—	189	189	—	2	—	—	2
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—
20.	Tunnies										
a)	*E. affinis*	—	—	—	—	—	—	—	—	—	—
b)	*Auxis* spp.	—	—	—	—	—	—	—	—	—	—
c)	*K. pelamis*	—	—	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	—	—	—
e)	Other tunnies	—	—	—	—	—	—	—	—	—	—
21.	Bill fishes	—	—	—	—	—	—	—	—	—	—
22.	Barracudas	3	2	9	112	126	1	1	—	28	30
23.	Mullets	—	—	—	—	—	—	—	—	—	—
24.	Unicorn cod	—	—	—	—	—	—	—	—	—	—
25.	Flat fishes										
a)	Halibut	—	—	—	—	—	—	—	—	—	—
b)	Flounders	—	—	—	—	—	—	—	—	—	—
c)	Soles	—	—	4	—	4	—	—	—	—	—
26.	Crustaceans										
a)	Penaeid prawns	268	461	175	110	1,014	573	1,063	199	226	2,061
b)	Non-penaeid prawns	—	—	—	—	—	—	—	—	—	—
c)	Lobsters	—	—	—	—	—	—	—	—	—	—
d)	Crabs	—	—	—	—	—	4	—	—	1	5
e)	Stomatopods	—	—	—	—	—	—	—	—	—	—
27.	Cephalopods	4	1	—	—	5	—	—	—	1	1
28.	Miscellaneous	226	2,968	2,194	326	5,714	728	1,266	1,016	76	3,086
	TOTAL	1,824	3,713	4,062	3,491	13,090	4,147	5,642	3,534	2,168	15,491
	No. of operations of fishing units	3,642	14,297	11,656	10,854	40,449	13,993	17,631	9,590	10,638	51,852

Table 8 (i). *Composition of marine fish landings from mechanised boats at Sakthikulangara during* 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1983–'84					1984–'85				
		Apr. to Jun. '83	Jul. to Sep. '83	Oct. to Dec. '83	Jan. to Mar. '84	Total	Apr. to Jun. '84	Jul. to Sep. '84	Oct. to Dec. '84	Jan. to Mar. '85	Total
1	2	3	4	5	6	7	8	9	10	11	12
1.	Elasmobranchs										
a)	Sharks	148	331	105	44	628	130	329	157	102	718
b)	Skates	—	—	12	—	12	—	6	—	—	6
c)	Rays	13	32	56	83	184	206	44	37	161	448
2.	Eels	—	—	—	—	—	—	—	—	—	—
3.	Cat fishes	725	1,054	626	102	2,507	1,162	823	453	3	2,441
4.	Clupeids										
a)	Wolf herring	—	—	1	—	1	—	—	10	—	10
b)	Oil sardine	437	13	1,401	—	1,851	—	—	54	133	187
c)	Other sardines	—	—	—	—	—	—	—	—	—	—
d)	Hilsa shad	—	—	—	—	—	—	—	—	—	—
e)	Other shads	—	—	—	—	—	—	—	—	—	—
f)	Anchovies										
	Coilia	—	—	—	—	—	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—	—	—
	Stolephorus	5	—	98	27	130	—	15	447	—	462
	Thrissina	—	—	—	—	—	—	—	—	—	—
	Thryssa	—	—	—	—	—	—	2	—	—	2
g)	Other clupeids	—	—	—	—	—	—	—	—	—	—
5.	Bombay duck	—	—	—	—	—	—	—	—	—	—
6.	Lizard fishes	1,378	2,784	295	232	4,689	1,667	2,098	1,624	1,044	6,433
7.	Half beaks & Full beaks	—	—	5	1	6	—	1	18	—	19
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
a)	Rock cods	—	—	—	254	254	—	—	—	2	2
b)	Snappers	—	—	—	249	249	—	—	—	—	—
c)	Pig-face breams	—	—	—	—	—	—	—	—	—	—
d)	Threadfin breams	451	4,506	406	526	5,889	1,254	11,545	933	1,894	15,626
e)	Other perches	110	1	24	311	446	374	11	43	1,197	1,625
10.	Goat fishes	—	—	—	—	—	—	1	—	—	1
11.	Threadfins	—	—	—	—	—	—	—	—	—	—
12.	Croakers	340	997	550	673	2,560	1,056	1,286	805	588	3,735
13.	Ribbon fishes	—	15	—	—	15	—	2	4	25	31
14.	Carangids										
a)	Horse mackerel	—	—	—	—	—	—	—	—	—	—
b)	Scads	14	45	12	—	71	—	124	185	30	339
c)	Leather-jackets	3	25	11	5	44	6	5	13	6	30
d)	Other carangids	6	72	88	47	213	79	41	82	12	214

1	2	3	4	5	6	7	8	9	10	11	12
15.	Silver bellies	142	17	64	360	583	98	24	30	314	466
16.	Big–jawed jumper	—	—	—	—	—	—	14	30	—	44
17.	Pomfrets										
a)	Black pomfret	12	36	34	3	85	21	22	57	5	105
b)	Silver pomfret	—	17	9	—	26	—	3	—	—	3
c)	Chinese pomfret	—	—	—	—	—	—	—	—	—	—
18.	Mackerels										
a)	Indian mackerel	38	68	20	—	126	121	44	116	18	299
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes										
a)	*S. commerson*	16	74	160	26	276	142	144	456	52	794
b)	*S. guttatus*	—	30	—	—	30	—	25	1	1	26
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—
20.	Tunnies										
a)	*E. affinis*	274	223	516	17	1,030	412	133	219	25	789
b)	*Auxis* spp.	—	7	—	—	7	—	1	—	—	1
c)	*K. pelamis*	—	—	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	—	—	—
e)	Other tunnies	—	2	—	—	2	—	5	—	—	5
21.	Bill fishes	5	6	16	2	29	10	16	36	4	66
22.	Barracudas	—	57	—	3	60	—	24	1	2	27
23.	Mullets	—	—	—	—	—	—	—	—	—	—
24.	Unicorn cod	—	—	—	—	—	—	—	—	—	—
25.	Flat fishes										
a)	Halibut	6	4	—	—	10	—	7	—	—	7
b)	Flounders	31	—	—	—	31	—	—	—	—	—
c)	Soles	276	1,746	233	249	2,504	759	2,060	363	592	3,774
26.	Crustaceans										
a)	Penaeid prawns	1,114	5,709	602	750	8,175	2,065	10,593	799	1,120	14,577
b)	Non–penaeid prawns	—	—	—	—	—	—	—	—	—	—
c)	Lobsters	—	6	4	3	13	4	2	6	11	23
d)	Crabs	2	18	3	7	30	19	1	6	36	62
e)	Stomatopods	206	8	550	533	1,297	106	9	1,245	565	1,925
27.	Cephalopods	120	318	320	48	806	599	879	1,610	445	3,533
28.	Miscellaneous	1,098	476	625	654	2,853	1,241	640	791	938	3,610
	TOTAL	6,970	18,697	6,846	5,209	37,722	11,531	30,979	10,631	9,324	62,465
	No. of operations of fishing units	32,378	45,718	27,139	22,518	1,27,753	40,377	50,093	35,455	21,017	1,46,94

Table 8 (j). *Composition of marine fish landings from mechanised boats at Cochin Fisheries Harbour during* 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1983–'84					1984–'85				
		Apr. to Jun. '83	Jul. to Sep. '83	Oct. to Dec. '83	Jan. to Mar. '84	Total	Apr. to Jun. '84	Jul. to Sep. '84	Oct. to Dec. '84	Jan. to Mar. '85	Total
1	2	3	4	5	6	7	8	9	10	11	12
1.	Elasmobranchs										
a)	Sharks	134	195	90	50	469	76	177	66	31	350
b)	Skates	—	—	—	—	—	—	—	—	—	—
c)	Rays	10	33	18	11	72	47	4	7	2	60
2.	Eels	—	—	1	—	1	—	1	—	—	1
3.	Cat fishes	181	329	176	8	694	987	549	144	5	1,685
4.	Clupeids										
a)	Wolf herring	—	—	6	1	7	—	3	2	2	7
b)	Oil sardine	1,794	1,235	2,718	6,272	12,019	1,813	664	6,037	3,597	12,111
c)	Other sardines	1	387	—	—	388	—	28	636	—	664
d)	Hilsa shad	—	—	—	—	—	—	—	—	—	—
e)	Other shads	—	—	—	—	—	—	—	—	—	—
f)	Anchovies										
	Coilia	—	—	—	—	—	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—	—	—
	Stolephorus	374	5	248	35	662	47	77	53	9	186
	Thrissina	—	—	—	—	—	—	—	—	—	—
	Thryssa	13	1	8	29	51	5	—	—	5	10
g)	Other clupeids	1	12	106	4	123	3	7	—	—	10
5.	Bombay duck	—	—	—	—	—	—	—	—	—	—
6.	Lizard fishes	79	88	2	3	172	199	118	—	25	342
7.	Half beaks & Full beaks	—	1	3	—	4	1	3	10	1	15
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
a)	Rock cods	—	—	—	33	33	—	7	4	69	80
b)	Snappers	6	—	—	13	19	—	—	2	27	29
c)	Pig-face breams	—	—	—	—	—	—	—	—	—	—
d)	Threadfin breams	56	858	5	111	1,030	685	4,426	—	237	5,348
e)	Other perches	127	22	11	52	212	88	32	—	81	201
10.	Goat fishes	—	—	—	—	—	—	—	—	—	—
11.	Threadfins	6	—	—	—	6	—	—	—	—	—
12.	Croakers	125	84	101	146	456	134	46	57	334	571
13.	Ribbon fishes	—	5	7	—	12	4	2	2	—	8
14.	Carangids										
a)	Horse mackerel	—	—	1	—	1	—	3	—	—	3
b)	Scads	2	31	—	—	33	15	500	—	2	517
c)	Leather-jackets	1	145	3	—	149	1	8	5	—	14
d)	Other carangids	79	39	405	17	540	116	236	53	51	456

1	2	3	4	5	6	7	8	9	10	11	12
15.	Silver bellies	80	4	9	5	98	11	5	1	25	42
16.	Big-jawed jumper	—	4	17	8	29	19	—	—	—	19
17.	Pomfrets										
a)	Black pomfret	13	51	194	1	259	8	82	52	3	145
b)	Silver pomfret	1	2	34	—	37	—	37	1	—	38
c)	Chinese pomfret	—	—	—	—	—	—	—	—	—	—
18.	Mackerels										
a)	Indian mackerel	33	498	844	3	1,378	123	926	1,488	381	2,918
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes										
a)	*S. commerson*	29	232	160	11	432	63	196	315	58	632
b)	*S. guttatus*	1	1	3	—	5	1	8	14	—	23
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—
20.	Tunnies										
a)	*E. affinis*	244	260	35	6	545	299	125	220	57	701
b)	*Auxis* spp.	4	108	1	1	114	79	35	3	19	136
c)	*K. pelamis*	—	—	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	2	1	2	4	4	1	20	1	26
e)	Other tunnies	—	10	1	—	11	9	13	2	1	25
21.	Bill fishes	—	6	1	—	7	11	9	5	—	25
22.	Barracudas	23	2	3	5	33	82	23	11	23	139
23.	Mullets	—	—	—	—	—	2	16	—	—	18
24.	Unicorn cod	—	—	—	—	—	—	—	—	—	—
25.	Flat fishes										
a)	Halibut	—	—	—	—	—	2	—	—	—	2
b)	Flounders	—	—	—	—	—	—	—	—	—	—
c)	Soles	74	233	79	191	577	143	182	11	85	421
26.	Crustaceans										
a)	Penaeid prawns	1,234	1,497	439	852	4,022	942	690	41	712	2,385
b)	Non-penaeid prawns	—	—	—	—	—	—	—	—	—	—
c)	Lobsters	—	—	—	—	—	—	—	—	1	1
d)	Crabs	55	—	2	62	119	38	—	1	33	72
e)	Stomatopods	44	—	275	100	419	95	—	43	53	191
27.	Cephalopods	19	17	6	6	48	48	33	3	33	117
28.	Miscellaneous	39	36	13	31	119	47	16	8	13	84
	TOTAL	4,882	6,433	6,026	8,068	25,409	6,247	9,288	9,317	5,976	30,828
	No. of operations of fishing units	19,625	19,944	12,188	16,761	68,518	23,145	18,219	9,286	15,051	65,701

Table 8 (k) *Composition of marine fish landings from mechanised boats at* **Mangalore** *during* 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1983–'84 Apr. to Jun. '83	Jul. to Sep. '83	Oct. to Dec. '83	Jan. to Mar. '84	Total	1984–'85 Apr. to Jun. '84	Jul. to Sep. '84	Oct. to Dec. '84	Jan. to Mar. '85	Total
1	2	3	4	5	6	7	8	9	10	11	12
1.	Elasmobranchs										
a)	Sharks	24	2	55	73	154	5	—	13	3	21
b)	Skates	—	—	—	—	—	—	—	—	—	—
c)	Rays	20	—	—	8	28	2	—	—	—	2
2.	Eels	—	—	—	—	—	—	—	—	—	—
3.	Cat fishes	568	2	540	598	1,708	22	—	15	38	75
4.	Clupeids										
a)	Wolf herring	9	—	1	1	11	—	—	3	—	3
b)	Oil sardine	1,633	2,913	2,148	1,979	8,673	979	5,394	6,102	1,186	13,661
c)	Other sardines	8	50	1,833	1	1,892	1	—	861	5	867
d)	Hilsa shad	—	—	—	—	—	—	—	—	—	—
e)	Other shads	11	—	—	—	11	—	—	—	—	—
f)	Anchovies	41				41					
	Coilia	—	—	—	—	—	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—	—	—
	Stolephorus	11	—	3,960	273	4,244	224	—	3,630	150	4,004
	Thrissina	—	—	—	—	—	—	—	—	—	—
	Thryssa	—	49	131	19	199	5	—	139	36	180
g)	Other clupeids	63	75	130	1	269	9	—	3,635	—	3,644
5.	Bombay duck	—	—	—	—	—	—	—	—	—	—
6.	Lizard fishes	409	—	86	148	643	63	—	18	31	112
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	1	—	1
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
a)	Rock cods	1	—	—	—	1	—	—	—	—	—
b)	Snappers	58	—	—	—	58	—	—	—	—	—
c)	Pig-face breams	—	—	—	—	—	—	—	19	—	19
d)	Threadfin breams	739	—	204	340	1,283	141	—	37	131	309
e)	Other perches	2	—	119	121	242	71	—	105	126	302
10.	Goat fishes	—	—	—	—	—	—	—	—	—	—
11.	Threadfins	—	—	—	—	—	—	—	—	—	—
12.	Croakers	176	26	351	151	704	103	—	50	102	255
13.	Ribbon fishes	134	3	10	—	147	60	—	76	19	155
14.	Carangids										
a)	Horse mackerel	—	—	85	—	85	—	—	—	—	—
b)	Scads	—	—	—	—	—	—	—	463	—	463
c)	Leather-jackets	—	—	—	—	—	—	—	—	—	—
d)	Other carangids	185	75	150	290	700	143	—	128	30	301

1	2	3	4	5	6	7	8	9	10	11	12
15.	Silver bellies	113	157	14	25	309	87	23	10	1	121
16.	Big-jawed jumper	43	—	26	58	127	17	—	7	8	32
17.	Pomfrets										
a)	Black pomfret	—	1	4	2	7	—	—	32	1	33
b)	Silver pomfret	15	—	15	43	73	4	—	12	—	16
c)	Chinese pomfret	—	—	—	—	—	—	—	—	—	—
18.	Mackerels										
a)	Indian mackerel	22	15	1,011	6	1,054	99	3,234	572	29	3,934
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes										
a)	*S. commerson*	7	17	104	14	142	—	—	68	12	80
b)	*S. guttatus*	—	3	18	7	28	—	—	104	1	105
c)	*S. lineolatus*	—	—	—	—	—	—	—	8	—	8
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—
20.	Tunnies										
a)	*E. affinis*	8	—	71	32	111	2	—	1	1	4
b)	*Auxis* spp.	—	—	—	—	—	—	—	1	—	1
c)	*K. pelamis*	—	—	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	10	1	11
e)	Other tunnies	—	—	—	—	—	—	—	9	—	9
21.	Bill fishes	—	—	—	—	—	—	—	—	—	—
22.	Barracudas	11	1	26	—	38	—	—	—	—	—
23.	Mullets	8	—	—	—	8	20	—	—	—	20
24.	Unicorn cod	—	—	—	—	—	—	—	—	—	—
25.	Flat fishes										
a)	Halibut	—	—	—	—	—	—	—	—	—	—
b)	Flounders	—	—	—	—	—	—	—	—	—	—
c)	Soles	212	27	237	258	734	188	39	527	283	1,037
26.	Crustaceans										
a)	Penaeid prawns	660	559	68	600	1,887	366	—	216	552	1,134
b)	Non-penaeid prawns	—	—	—	—	—	—	—	—	—	—
c)	Lobsters	—	—	—	—	—	—	—	—	—	—
d)	Crabs	109	—	4	113	226	10	—	5	17	32
e)	Stomatopods	392	—	235	1,257	1,884	717	—	185	601	1,503
27.	Cephalopods	62	—	16	97	175	77	—	26	42	145
28.	Miscellaneous	377	3	3	197	580	117	—	—	—	117
	TOTAL	6,131	3,978	11,655	6,712	28,476	3,532	8,690	17,088	3,406	32,716
	No. of operations of fishing units	20,740	3,815	12,454	14,358	51,367	9,055	2,440	16,373	6,629	24,497

Table 8 (l). *Composition of marine fish landings from mechanised boats at New Ferry Wharf, Bombay during* 1983–'84 *and* 1984–'85 *(figures in tonnes)*

Sl. No.	Name of fish	1983–'84 Apr. to Jun. '83	Jul. to Sep. '83	Oct. to Dec. '83	Jan. to Mar. '84	Total	1984–'85 Apr. to Jun. '84	Jul. to Sep. '84	Oct. to Dec. '84	Jan. to Mar. '85	Total
1	2	3	4	5	6	7	8	9	10	11	12
1.	Elasmobranchs										
a)	Sharks	318	104	603	355	1,380	212	138	343	236	929
b)	Skates	454	164	515	1,009	2,142	241	1	234	385	861
c)	Rays	578	148	475	992	2,193	239	63	244	406	952
2.	Eels	648	34	182	1,251	2,115	334	101	602	1,515	2,552
3.	Cat fishes	535	94	720	722	2,071	308	183	314	446	1,251
4.	Clupeids										
a)	Wolf herring	116	26	120	134	396	64	58	94	136	352
b)	Oil sardine	—	—	—	—	—	—	—	12	2	14
c)	Other sardines	—	—	—	—	—	1	—	—	—	1
d)	Hilsa shad	—	—	—	—	—	—	—	—	—	—
e)	Other shads	—	—	—	3	3	—	37	15	1	53
f)	Anchovies	—	—	—	—	—	—	—	—	—	—
	Coilia	239	47	241	325	852	117	249	659	544	1,569
	Setipinna	—	—	—	—	—	—	—	—	—	—
	Stolephorus	5	3	3	11	22	12	14	10	12	48
	Thrissina	—	—	—	—	—	—	—	—	—	—
	Thryssa	—	2	6	—	8	7	—	—	15	22
g)	Other clupeids	163	59	165	123	510	26	8	77	102	213
5.	Bombay duck	145	73	78	128	424	48	172	435	59	714
6.	Lizard fishes	173	35	379	89	676	192	112	268	70	642
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
a)	Rock cods	—	4	11	—	15	—	—	44	18	62
b)	Snappers	—	3	353	21	377	—	—	207	51	258
c)	Pig-face breams	—	—	—	—	—	—	—	—	—	—
d)	Threadfin breams	907	35	393	232	1,567	230	143	703	182	1,258
e)	Other perches	316	35	104	218	673	28	31	38	90	187
10.	Goat fishes	212	54	428	98	792	63	44	289	52	448
11.	Threadfins	29	—	15	39	83	11	16	109	78	214
12.	Croakers	1,137	173	1,466	1,675	4,451	526	581	2,221	1,410	4,738
13.	Ribbon fishes	507	48	667	456	1,673	497	208	509	335	1,549
14.	Carangids										
a)	Horse mackerel	—	—	151	—	151	—	—	30	33	63
b)	Scads	—	—	—	—	—	—	—	—	—	—
c)	Leather-jackets	—	80	32	—	112	1	50	68	—	119
d)	Other carangids	258	65	429	201	953	50	12	112	127	301

1	2	3	4	5	6	7	8	9	10	11	12
15.	Silver bellies	—	—	—	—	—	—	—	—	—	—
16.	Big-jawed jumper	222	32	151	246	651	43	2	34	85	164
17.	Pomfrets										
a)	Black pomfret	26	—	7	40	73	2	15	3	9	29
b)	Silver pomfret	74	37	47	76	234	47	34	86	125	292
c)	Chinese pomfret	—	—	—	—	—	—	—	—	—	—
18.	Mackerels										
a)	Indian mackerel	—	1	194	25	220	—	—	142	10	152
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes										
a)	*S. commerson*	49	72	286	5	412	15	85	581	76	757
b)	*S. guttatus*	29	41	165	4	239	2	30	61	—	93
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—
20.	Tunnies										
a)	*E. affinis*	—	195	554	7	756	8	60	243	32	343
b)	*Auxis* spp.	—	39	831	—	870	—	—	—	—	—
c)	*K. pelamis*	—	—	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	—	—	—
e)	Other tunnies	—	67	—	84	151	—	—	62	50	112
21.	Bill fishes	—	—	—	—	—	—	—	—	—	—
22.	Barracudas	—	—	—	—	—	—	—	—	—	—
23.	Mullets	—	—	—	—	—	—	—	—	—	—
24.	Unicorn cod	—	2	—	—	2	—	—	—	—	—
25.	Flat fishes										
a)	Halibut	162	40	272	91	565	28	22	286	59	395
b)	Flounders	—	—	—	—	—	—	—	—	—	—
c)	Soles	86	36	84	121	327	114	73	157	130	474
26.	Crustaceans										
a)	Penaeid prawns	1,809	1,263	4,820	1,929	9,821	1,184	4,890	4,229	2,243	12,546
b)	Non-penaeid prawns	30	51	54	106	241	186	221	132	70	609
c)	Lobsters	37	20	48	39	144	83	19	138	78	318
d)	Crabs	37	11	32	46	126	49	59	78	39	225
e)	Stomatopods	—	—	—	—	—	—	—	—	—	—
27.	Cephalopods	382	23	1,946	798	3,149	292	86	1,135	848	2,331
28.	Miscellaneous	153	55	178	295	681	148	173	261	257	839
	TOTAL	9,831	3,271	17,205	11,994	42,301	5,408	7,960	15,265	10,418	39,051
	No. of operations of fishing units	6,015	2,863	10,827	7,355	27,060	4,323	4,551	8,762	7,490	25,126

Table 8 (m). *Composition of marine fish landings from mechanised boats at Sassoon Dock, Bombay during 1983–'84 and 1984–'85 (figures in tonnes)*

Sl. No.	Name of fish	1983–'84 Apr. to Jun. '83	Jul. to Sep. '83	Oct. to Dec. '83	Jan. to Mar. '84	Total	1984–'85 Apr. to Jun. '84	Jul. to Sep. '84	Oct. to Dec. '84	Jan. to Mar. '85	Total
1	2	3	4	5	6	7	8	9	10	11	12
1.	Elasmobranchs										
a)	Sharks	216	207	373	337	1,133	219	316	519	400	1,454
b)	Skates	38	47	43	46	174	39	56	61	48	204
c)	Rays	75	68	82	110	335	65	94	131	128	418
2.	Eels	49	—	3	46	98	19	—	41	69	129
3.	Cat fishes	378	191	349	1,011	1,929	452	324	608	590	1,974
4.	Clupeids										
a)	Wolf herring	93	12	168	145	418	53	50	170	103	376
b)	Oil sardine	—	—	—	—	—	—	11	21	6	38
c)	Other sardines	3	1	3	2	9	—	—	19	—	19
d)	Hilsa shad	—	—	—	—	—	—	—	—	—	—
e)	Other shads	23	—	41	41	105	3	16	48	34	101
f)	Anchovies										
	Coilia	209	207	288	84	788	84	123	161	116	484
	Setipinna	—	—	—	—	—	—	—	—	—	—
	Stolephorous	2	—	16	45	63	13	3	—	—	16
	Thrissina	—	—	—	—	—	—	—	—	—	—
	Thryssa	31	79	50	81	241	43	149	98	60	350
g)	Other clupeids	79	3	74	219	375	71	110	124	88	393
5.	Bombay duck	89	222	21	1	333	42	378	80	37	537
6.	Lizard fishes	220	42	171	73	506	161	33	272	181	647
7.	Half beaks & Full beaks	—	—	—	—	—	—	—	—	—	—
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
a)	Rock cods	17	—	—	—	17	2	—	5	25	32
b)	Snappers	—	—	4	1	5	—	—	86	—	86
c)	Pig-face breams	—	—	—	—	—	—	—	—	—	—
d)	Threadfin breams	925	227	257	304	1,713	295	362	726	448	1,831
e)	Other perches	27	39	32	37	135	20	25	30	3	78
10.	Goat fishes	110	72	90	29	301	39	52	212	25	328
11.	Threadfins	48	80	53	99	280	10	—	14	25	49
12.	Croakers	305	240	575	754	1,874	347	423	830	619	2,219
13.	Ribbon fishes	245	168	194	214	821	139	219	404	392	1,154
14.	Carangids										
a)	Horse mackerel	—	2	13	8	23	7	21	17	—	45
b)	Scads	—	—	—	—	—	—	—	—	—	—
c)	Leather-jackets	1	9	21	1	32	2	11	28	—	41
d)	Other carangids	46	35	59	53	193	29	42	76	32	179

1	2	3	4	5	6	7	8	9	10	11	12
15.	Silver bellies	—	3	—	—	3		—	—	—	—
16.	Big-jawed jumper	92	62	73	117	344	27	4	48	48	127
17.	Pomfrets										
a)	Black pomfret	25	16	50	14	105	24	25	73	21	143
b)	Silver pomfret	89	148	280	128	645	79	107	197	125	508
c)	Chinese pomfret	—	—	—	—	—	—	—	—	—	—
18.	Mackerels										
a)	Indian mackerel	—	—	—	—	—	—	11	13	16	40
b)	Other mackerel	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes										
a)	*S. commerson*	17	5	29	41	92	3	21	105	87	216
b)	*S. guttatus*	64	7	162	103	336	47	—	123	107	277
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—
20.	Tunnies										
a)	*E. affinis*	3	13	65	166	247	24	77	201	115	417
b)	*Auxis* spp.	—	—	—	—	—	—	—	—	—	—
c)	*K. pelamis*	—	—	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	—	—	—
e)	Other tunnies	11	—	—	—	11	—	—	—	—	—
21.	Bill fishes	19	—	28	37	84	80	7	43	41	100
22.	Barracudas	37	7	12	3	59	—	6	142	43	191
23.	Mullets	—	—	—	—	—	—	—	—	—	—
24.	Unicorn cod	1	—	—	—	1	—	—	—	—	—
25.	Flat fishes										
a)	Halibut	18	—	27	8	53	8	5	54	9	76
b)	Flounders	—	—	—	—	—	—	—	—	—	—
c)	Soles	42	81	26	53	202	28	73	41	18	160
26.	Crustaceans										
a)	Penaeid prawns	1,158	5,934	3,291	2,034	12,417	1,251	10,127	3,225	3,221	17,824
b)	Non-penaeid prawns	373	289	465	189	1,316	212	365	236	221	1,034
c)	Lobsters	25	80	24	67	196	119	84	67	57	327
d)	Crabs	9	50	13	19	91	30	32	13	—	75
e)	Stomatopods	—	—	—	—	—	—	—	—	—	—
27.	Cephalopods	271	33	1,194	626	2,124	308	104	2,867	1,674	4,953
28.	Miscellaneous	84	197	138	165	494	89	151	199	148	587
	TOTAL	5,567	8,786	8,857	7,511	30,721	4,412	14,017	12,428	9,380	40,237
	No. of operations of fishing units	8,004	10,083	11,362	12,403	—	7,776	12,093	12,637	10,008	—

Table 8 (n). *Composition of marine fish landings from mechanised boats at Veraval during 1983–'84 and 1984–'85 (figures in tonnes)*

Sl. No.	Name of fish	1983–'84					1984–'85				
		Apr. to Jun. '83	Jul. to Sep. '83	Oct. to Dec. '83	Jan. to Mar. '84	Total	Apr. to Jun. '84	Jul. to Sep. '84	Oct. to Dec. '84	Jan. to Mar. '85	Total
1	2	3	4	5	6	7	8	9	10	11	12
1.	Elasmobranchs										
a)	Sharks	182	25	96	79	382	175	156	166	279	776
b)	Skates	14	—	55	85	154	96	—	36	190	322
c)	Rays	142	15	135	404	696	337	7	30	76	450
2.	Eels	371	46	241	330	988	180	46	469	243	938
3.	Cat fishes	242	5	199	110	556	117	37	140	259	553
4.	Clupeids										
a)	Wolf herring	151	66	171	178	566	74	101	114	221	510
b)	Oil sardine	—	—	—	—	—	—	—	—	—	—
c)	Other sardines	16	16	14	13	59	3	6	1	—	10
d)	Hilsa shad	—	—	69	—	69	—	—	22	5	27
e)	Other shads	71	36	40	200	347	152	116	251	301	820
f)	Anchovies										
	Coilia	51	48	—	592	691	294	6	20	48	368
	Stolephorus	—	—	—	—	—	—	—	—	—	—
	Setipinna	—	—	—	—	—	—	—	—	—	—
	Thrissina	—	—	—	—	—	—	—	—	—	—
	Thryssa	295	74	398	459	1,226	199	112	193	69	573
g)	Other clupeids	116	5	111	167	399	155	18	413	236	822
5.	Bombay duck	82	—	—	86	168	78	—	—	4	82
6.	Lizard fishes	143	—	202	977	1,322	141	—	222	265	628
7.	Half beaks & Full beaks	—	—	—	3	3	4	5	3	3	15
8.	Flying fishes	—	—	—	—	—	—	—	—	—	—
9.	Perches										
a)	Rock cods	1	—	269	138	408	98	1	117	149	365
b)	Snappers	45	—	394	103	542	34	7	34	133	208
c)	Pig-face breams	—	—	—	—	—	60	—	6	35	101
d)	Threadfin breams	—	—	549	545	1,094	865	—	676	859	2,400
e)	Other perches	466	—	529	646	1,641	428	34	334	314	1,110
10.	Goat fishes	79	—	424	196	699	28	—	95	176	299
11.	Threadfins	213	—	303	168	684	356	53	174	160	743
12.	Croakers	2,921	15	2,387	2,248	7,571	2,620	717	3,256	2,820	9,413
13.	Ribbon fishes	1,014	14	629	625	2,282	1,122	91	628	905	2,746
14.	Carangids										
a)	Horse mackerel	6	47	3	17	73	20	81	14	77	192
b)	Scads	—	8	62	—	70	—	—	—	—	—
c)	Leather-jackets	1	—	6	13	20	5	35	18	1	59
d)	Other carangids	24	—	32	26	82	48	22	66	101	237

1	2	3	4	5	6	7	8	9	10	11	12
15.	Silver bellies	—	—	24	305	329	—	34	117	306	457
16.	Big-jawed jumper	561	574	2,349	1,266	4,750	357	178	1,554	560	2,649
17.	Pomfrets										
a)	Black pomfret	36	12	22	37	107	227	34	10	41	312
b)	Silver pomfret	74	56	23	57	210	49	56	124	59	288
c)	Chinese pomfret	—	—	—	—	—	—	—	—	—	—
18.	Mackerels										
a)	Indian mackerel	—	—	—	—	—	—	—	40	8	48
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—
19.	Seer fishes										
a)	*S. commerson*	—	—	—	—	—	—	—	1	211	212
b)	*S. guttatus*	41	61	121	115	338	42	310	142	1	495
c)	*S. lineolatus*	—	—	—	—	—	—	—	—	—	—
d)	*Acanthocybium* spp.	—	—	—	—	—	—	—	—	—	—
20.	Tunnies										
a)	*E. affinis*	16	10	30	16	72	29	65	118	86	298
b)	*Auxis* spp.	—	—	—	—	—	—	—	—	5	5
c)	*K. pelamis*	—	—	—	—	—	—	—	—	—	—
d)	*T. tonggol*	—	—	—	—	—	—	—	—	—	—
e)	Other tunnies	—	—	—	—	—	—	—	13	16	29
21.	Bill fishes	—	—	98	5	103	—	—	—	5	5
22.	Barracudas	3	—	195	13	211	21	—	31	34	86
23.	Mullets	—	—	—	—	—	—	—	—	—	—
24.	Unicorn cod	—	—	—	—	—	—	—	—	—	—
25.	Flat fishes										
a)	Halibut	5	3	104	61	173	50	3	161	162	376
b)	Flounders	—	—	—	—	—	—	—	—	—	—
c)	Soles	124	—	276	649	1,049	2,059	61	665	499	3,284
26.	Crustaceans										
a)	Penaeid prawns	321	12	682	363	1,378	1,328	177	686	900	3,091
b)	Non-penaeid prawns	135	10	120	170	435	467	13	43	368	891
c)	Lobsters	23	4	61	52	140	94	4	112	77	287
d)	Crabs	138	9	97	2,083	2,327	3,257	1	273	1,620	5,151
e)	Stomatopods	15	—	174	285	474	346	13	286	336	981
27.	Cephalopods	882	8	1,115	271	2,276	299	4	506	864	1,673
28.	Miscellaneous	1,413	40	725	731	2,909	1,022	223	1,948	979	4,172
	TOTAL	10,433	1,219	13,534	14,887	40,073	17,336	2,827	14,328	15,066	49,557
	No. of operations of fishing units	38,048	2,772	18,383	12,212	71,415	16,956	8,932	15,926	22,602	64,416

Table 9. *Estimated marine fish landings in India during 1983 (figures in tonnes)*

Sl. No.	Name of fish	West Bengal	Orissa	Andhra Pradesh	Tamil Nadu	Pondi-cherry	Kerala	Karna-taka	Goa	Mahara-shtra	Gujarat	Anda-mans	Laksha-dweep	Larger trawlers	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Elasmobranchs														
a)	Sharks	223	1,408	6,706	3,095	45	7,747	3,801	628	8,205	6,818	295	256	127	39,354
b)	Skates	98	14	404	768	3	34	9	—	2,189	611	1	76	27	4,234
c)	Rays	268	106	1,676	16,084	286	740	185	31	2,871	4,154	9	—	38	26,458
2.	Eels	11	14	472	211	30	31	1	4	3,015	4,438	—	—	75	8,302
3.	Cat fishes	1,501	4,528	3,606	4,620	64	15,344	7,273	1,522	12,008	10,176	34	—	88	60,764
4.	Clupeids														
a)	Wolf herring	910	1,036	1,930	2,710	114	1,090	223	73	5,293	3,343	37	—	9	16,768
b)	Oil sardine	—	—	—	1,320	141	1,54,880	21,701	5,555	109	—	—	—	—	1,83,706
c)	Other sardines	41	5,263	17,514	37,124	3,399	5,315	6,086	658	533	57	1,019	—	1	77,010
d)	Hilsa shad	1,005	421	62	563	18	167	2	—	806	832	—	—	—	3,876
e)	Other shads	42	253	3,776	6,097	380	—	16	5	1,606	3,681	34	—	—	15,890
f)	Anchovies														
	Coilia	581	859	40	634	19	—	—	76	10,336	6,017	—	—	—	18,562
	Setipinna	616	1,288	49	6	—	—	19	—	—	—	—	—	—	1,978
	Stolephorus	46	649	8,127	9,723	291	55,042	10,952	359	203	3,751	114	—	—	89,257
	Thrissina	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Thryssa	172	116	3,855	5,400	402	1,172	1,569	1,021	2,296	—	18	—	—	16,021
g)	Other clupeids	302	3,070	5,155	7,156	469	6,727	3,123	367	4,512	2,814	—	—	—	33,695
5.	Bombay duck	4,566	313	1,076	6	2	—	11	12	45,113	49,851	—	—	—	1,00,950
6.	Lizard fishes	—	289	1,139	1,828	300	5,456	1,364	540	3,236	627	—	—	129	14,908
7.	Half beaks & Full beaks	—	1	66	1,327	174	483	97	29	201	331	18	103		2,830
8.	Flying fishes	—	9	74	1,048	326	—	—	—	2	—	10	25	—	1,494
9.	Perches														
a)	Rock cods	—	6	8	1,638	24	384	25	4	60	332	—	—	216	2,697
b)	Snappers	—	20	1,055	1,063	16	92	59	2	380	808	—	—	135	3,630
c)	Pig-face breams	—	—	7	2,265	49	101	—	—	8	—	—	—	—	2,430
d)	Threadfin breams	—	523	2,975	3,453	854	7,297	3,834	1,260	5,821	1,191	—	—	68	27,276
e)	Other perches	20	350	4,783	5,872	532	2,003	510	229	1,975	2,695	604	252	283	20,108
10.	Goat fishes	—	218	1,431	2,419	85	152	17	—	1,438	514	—	32	14	6,320
11.	Threadfins	41	16	1,226	387	10	176	16	—	492	3,546	14	—	23	5,947
12.	Croakers	1,357	12,766	11,554	13,143	454	6,112	4,067	2,697	18,278	29,647	4	—	676	1,00,755
13.	Ribbon fishes	199	996	10,657	5,348	45	1,109	2,266	1,061	10,909	6,305	—	—	176	39,071
14.	Carangids														
a)	Horse mackerel	—	196	810	59	—	398	433	75	383	456	—	—	—	2,810
b)	Scads	—	212	3,782	781	75	5,221	24	1	—	914	—	—	3	11,013
c)	Leather-jackets	408	53	1,638	3,474	30	487	1,377	16	1,260	1,262	—	—	—	10,005
d)	Other carangids	7	343	3,463	7,040	516	10,420	2,526	944	3,013	453	315	147	67	29,254
15.	Silver bellies	75	587	8,154	62,116	1,763	9,511	7,024	1,342	929	37	195	—	—	91,733
16.	Big-jawed jumper	—	15	1,119	357	—	1,099	1,132	1,593	3,146	11,562	—	—	—	20,023
17.	Pomfrets														
a)	Black pomfret	473	366	1,996	629	49	980	1,300	158	3,116	2,958	10	—	2	12,037
b)	Silver pomfret	5,775	2,479	2,904	647	15	898	551	165	19,406	9,139	47	—	14	42,039
c)	Chinese pomfret	40	10	26	15	—	118	4	—	1	—	—	—	—	214

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
18.	Mackerels														
a)	Indian mackerel	7	2,015	6,525	5,879	933	12,683	2,182	220	418	—	241	—	44	31,147
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—	80	—	—	80
19.	Seer fishes														
a)	*S. commerson*	508	157	2,369	4,041	97	444	3,340	257	2,486	3,773	102	26	42	21,642
b)	*S. guttatus*	292	831	3,740	309	21	2,477	692	467	4,709	—	100	33	10	13,681
c)	*S. lineolatus*	—	—	—	170	—	24	36	—	—	—	—	—	—	230
d)	*Acanthocybium* spp.	—	—	—	8	—	54	—	—	—	—	—	—	—	62
20.	Tunnies														
a)	*E. affinis*	—	28	726	1,515	5	3,804	1,358	—	1,574	415	—	35	—	9,460
b)	*Auxis* spp.	—	8	8	406	—	834	409	—	872	—	—	—	—	2,537
c)	*K. pelamis*	—	1	—	34	102	2	27	—	—	—	85	2,576	—	2,827
d)	*T. tonggol*	—	—	—	6	—	10	1	—	—	—	—	—	—	17
e)	Other tunnies	—	—	32	46	11	1,100	—	25	178	12	22	692	—	2,118
21.	Bill fishes	—	5	345	124	11	95	43	—	99	117	40	33	—	912
22.	Barracudas	—	31	243	1,411	35	1,140	100	—	278	464	50	19	22	3,793
23.	Mullets	17	4	110	451	47	116	11	6	156	2,287	171	—	—	3,376
24.	Unicorn cod	—	—	—	—	—	—	—	17	131	—	—	—	—	148
25.	Flat fishes														
a)	Halibut	—	—	100	262	3	160	8	17	801	406	—	—	11	1,768
b)	Flounders	—	—	139	13	8	45	68	—	—	—	—	—	6	279
c)	Soles	37	326	971	2,779	284	13,118	2,483	847	2,704	1,178	—	—	—	24,727
26.	Crustaceans														
a)	Penaeid prawns	410	1,999	10,571	13,458	292	29,754	7,883	7,744	36,027	9,959	72	—	34	1,18,203
b)	Non-penaeid prawns	1,699	19	5,851	275	9	105	—	—	32,134	8,657	1	—	—	48,750
c)	Lobsters	—	3	20	355	32	68	—	8	329	482	3	—	1	1,301
d)	Crabs	359	186	3,047	10,172	711	474	533	737	329	2,779	10	—	20	19,357
e)	Stomatopods	32	199	612	878	7	6,341	7,701	2,662	1,142	2,199	—	—	—	21,773
27.	Cephalopods	18	119	519	3,877	121	1,727	979	394	6,613	3,972	—	16	1,393	19,748
28.	Miscellaneous	970	675	2,241	23,988	1,193	6,404	2,147	3,850	5,682	9,312	112	221	325	57,120
	TOTAL	23,126	45,399	1,51,484	2,80,882	14,902	3,85,765	1,11,598	37,688	2,69,811	2,15,332	3,867	4,542	4,079	15,48,475

Table 10. *Estimated marine fish landings in India during 1983–'84 (figures in tonnes)*

Sl. No.	Name of fish	West Bengal	Orissa	Andhra Pradesh	Tamil Nadu	Pondi-cherry	Kerala	Karna-taka	Goa	Maha-rashtra	Gujarat	Anda-mans	Laksha-dweep	Larger trawlers	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Elasmobranchs														
a)	Sharks	340	1,566	7,162	2,392	156	8,678	3,136	568	7,850	6,323	403	252	193	39,019
b)	Skates	90	15	408	750	3	13	33	—	2,355	369	—	—	30	4,066
c)	Rays	246	211	2,295	15,309	148	1,149	166	76	3,001	5,076	12	73	40	27,802
2.	Eels	29	11	619	225	31	32	2	32	2,597	3,997	—	—	132	7,707
3.	Cat fishes	1,820	5.707	3,916	5,327	53	16,121	6,076	1,256	13,377	10,567	42	—	103	64,365
4.	Clupeids														
a)	Wolf herring	480	1,040	1,962	2,645	125	989	180	85	5,961	3,079	54	—	35	16,635
b)	Oil sardine	—	—	—	1,196	736	1,49,740	23,917	3,604	888	—	—	—	—	1,80,081
c)	Other sardines	33	4,891	21,411	34,377	2,707	4,679	6,957	528	166	75	1,016	—	1	76,841
d)	Hilsa shad	1,011	407	32	1,093	19	95	—	—	512	854	—	—	—	4,023
e)	Other shads	48	231	7,418	6,596	518	—	16	6	1,725	4,655	43	—	—	21,256
f)	Anchovies														
	Coilia	1,461	641	23	742	32	—	11	76	10,100	5,004	—	—	—	18,090
	Setipinna	2,338	987	30	8	—	—	19	—	—	—	—	—	—	3,382
	Stolephorus	85	255	9,144	10,227	361	56,101	11,502	429	1,588	—	110	—	—	89,802
	Thryssa	192	173	3,218	4,534	331	1,268	2,110	894	1,693	3,431	43	—	—	17,887
g)	Other clupeids	459	3,428	5,951	6,732	543	6,729	3,066	410	5,229	2,661	—	—	—	35,208
5.	Bombay duck	4,645	304	1,021	—	—	—	13	12	39,594	49,852	—	—	—	95,441
6.	Lizard fishes	—	132	1,284	1,836	246	5,572	1,341	853	2,711	1,468	—	—	170	15,613
7.	Half beaks & Full beaks	2	8	83	1,264	144	351	96	33	152	335	40	95	—	2,603
8.	Flying fishes	—	—	75	1,039	326	3	—	—	2	—	9	29	—	1,483
9.	Perches														
a)	Rock cods	—	6	8	1,040	2	575	38	4	61	628	—	—	273	2,635
b)	Snappers	—	12	909	714	17	216	59	—	415	1,246	—	—	205	3,793
c)	Pig-face breams	—	—	6	2,006	57	96	—	—	10	26	—	—	—	2,201
d)	Threadfin breams	—	755	3,298	3,264	746	7,875	3,030	878	4,969	2,531	—	—	101	27,447
e)	Other perches	42	281	4,348	5,524	387	3,064	624	190	1,339	3,385	593	257	392	20,426
10.	Goat fishes	—	121	1,322	2,081	79	58	10	—	1,211	710	—	34	20	5,646
11.	Threadfins	40	36	1,486	400	10	258	17	1	473	4,649	17	—	25	7,412
12.	Croakers	2,813	16,578	11,768	12,961	644	7,431	3,869	2,202	18,465	30,769	5	—	1,067	1,08,572
13.	Ribbon fishes	1,111	1,183	8,512	5,476	184	1,127	2,040	847	11,229	7,320	—	—	459	39,488
14.	Carangids														
a)	Horse mackerel	—	218	849	63	—	374	471	75	457	578	—	—	8	3,093
b)	Scads	—	43	2,139	1,007	56	4,972	24	1	—	914	—	—	4	9,160
c)	Leather-jackets	88	75	1,652	3,473	37	383	1,363	16	1,183	1,307	—	—	—	9,577
d)	Other carangids	7	462	3,665	6,854	549	9,101	2,489	1,924	2,929	495	363	170	111	29,099
15.	Silver bellies	90	414	6,867	60,877	1,786	9,185	5,433	1,485	1,005	342	287	—	1	87,772
16.	Big-jawed jumper	—	12	993	344	—	953	934	1,568	2,836	11,792	—	—	—	19,432
17.	Pomfrets														
a)	Black pomfret	336	394	6,674	609	50	911	1,321	46	3,076	3,091	10	—	6	16,524
b)	Silver pomfret	5,372	2,604	3,556	534	53	730	603	214	20,621	6,229	50	—	39	40,605
c)	Chinese pomfret	30	5	70	13	—	130	4	7	1	—	—	—	—	260

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
18.	Mackerels														
a)	Indian mackerel	6	1,605	6,726	8,009	813	12,708	2,479	256	619	—	251	—	44	33,516
b)	Other mackerels	—	—	—	—	—	—	—	—	—	—	89	—	—	89
19.	Seer fishes														
a)	*S. commerson*	335	217	2,410	3	95	4,013	3,214	257	2,636	—	104	32	117	13,433
b)	*S. guttatus*	161	1,061	4,792	3,333	21	2,478	709	478	4,550	4,179	100	31	10	21,903
c)	*S. lineolatus*	—	—	42	210	—	33	1	—	—	—	—	—	—	286
d)	*Acanthocybium* spp.	—	—	—	147	—	54	—	—	—	—	—	—	—	201
20.	Tunnies														
a)	*E. affinis*	—	16	748	2,001	3	3,862	1,683	—	1,717	1,018	—	31	—	11,079
b)	*Auxis* spp.	—	—	8	387	—	901	425	—	872	—	—	—	—	2,593
c)	*K. pelamis*	—	—	—	63	102	3	28	—	—	—	82	2,373	—	2,651
d)	*T. tonggol*	—	—	1	3	—	6	1	—	—	—	—	—	—	11
e)	Other tunnies	—	—	64	47	—	1,162	8	25	168	559	21	638	—	2,692
21.	Bill fishes	—	—	71	206	6	118	44	—	109	125	42	37	—	758
22.	Barracudas	—	19	244	1,516	31	1,105	81	6	252	235	59	21	29	3,598
23.	Mullets	7	1	50	505	50	117	11	5	160	2,298	204	—	—	3,408
24.	Unicorn cod	—	—	—	—	—	—	—	—	452	—	—	—	—	452
25.	Flat fishes														
a)	Halibut	—	—	128	248	23	204	4	17	703	373	—	—	18	1,718
b)	Flounders	—	—	138	15	8	41	68	—	—	—	—	—	19	289
c)	Soles	38	324	990	2,411	260	13,664	2,212	781	2,805	2,168	—	—	—	25,653
26.	Crustaceans														
a)	Penaeid prawns	1,662	1,936	12,106	15,029	621	26,100	6,950	5,938	36,805	9,350	94	—	28	1,16,619
b)	Non-penaeid prawns	4,391	15	5,567	146	11	170	—	—	32,714	7,618	1	—	—	50,633
c)	Lobsters	—	3	17	447	24	56	3	6	381	1,311	3	—	2	2,253
d)	Crabs	376	151	3,025	9,997	609	569	571	1,328	590	9,216	9	—	20	26,461
e)	Stomatopods	23	60	621	970	5	8,407	10,978	2,989	1,466	3,159	—	—	—	28,678
27.	Cephalopods	36	94	605	3,113	72	1,677	258	452	6,826	3,725	—	13	1,704	18,575
28.	Miscellaneous	1,620	727	2,173	24,696	1,204	6,647	1,930	5,726	5,260	10,209	157	235	632	61,216
	TOTAL	31,863	49,435	1,64,700	2,77,034	15,094	3,83,054	1,12,628	36,584	2,68,866	2,29,301	4,313	4,301	6,038	15,83,211

Table 11. *Estimated marine fish landings in India during 1984 (figures in tonnes)*

Sl. No.	Name of fish	West Bengal	Orissa	Andhra Pradesh	Tamil Nadu	Pondi-cherry	Kerala	Karna-taka	Goa	Maha-rashtra	Gujarat	Anda-mans	Laksha-dweep	Larger trawlers	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Elasmobranchs														
a)	Sharks	265	1,247	6,627	2,395	256	6,269	1,427	508	7,276	6,777	274	198	110	33,629
b)	Skates	35	33	609	149	—	12	32	—	1,733	477	35	—	3	3,118
c)	Rays	144	401	2,795	9,381	169	1,356	142	205	2,499	3,796	30	89	3	21,010
2.	Eels	48	10	691	288	2	19	2	28	2,868	3,049	—	—	107	7,112
3.	Cat fishes	2,211	5,993	5,480	4,197	68	11,582	3,722	1,272	13,418	9,313	121	—	38	57,415
4.	Clupeids														
a)	Wolf herring	352	845	2,034	2,641	76	1,372	501	149	6,203	2,858	67	—	27	17,125
b)	Oil sardine	—	539	—	1,195	920	1,46,893	36,323	1,675	1,287	—	—	—	—	1,88,832
c)	Other sardines	24	3,311	21,077	26,223	1,155	6,268	5,445	2,441	254	274	1,122	—	—	67,594
d)	Hilsa shad	2,101	1,665	57	1,127	—	198	15	—	556	72	106	—	—	5,897
e)	Other shads	292	208	7,195	5,189	303	—	1	1	2,525	4,844	—	—	—	20,558
f)	Anchovies	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Coilia	1,415	633	114	712	18	—	9	8	11,593	6,625	—	—	—	21,127
	Setipinna	2,436	1,086	—	12	—	—	—	—	—	—	—	—	—	3,534
	Stolephorus	65	322	4,404	14,521	586	41,513	11,480	336	1,608	—	116	—	—	74,951
	Thrissina	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Thryssa	57	72	3,435	7,721	732	1,419	1,121	1,454	2032	2,474	92	—	—	20,609
g)	Other clupeids	1,343	2,379	6,712	5,667	582	5,313	5,185	501	5,433	4,886	—	—	—	38,001
5	Bombay duck	2,166	303	1,023	4	—	—	2	—	58,367	55,887	—	—	—	1,17,742
6.	Lizard fishes	—	132	1,217	2,184	130	6,281	591	736	2,170	1,620	—	—	129	15,190
7.	Half beaks & Full beaks	3	8	138	921	10	311	98	4	46	16	96	62	—	1,713
8.	Flying fishes	—	—	39	2,157	451	3	1	—	—	—	—	15	—	2,666
9.	Perches														
a)	Rock cod	—	—	15	1,474	11	483	42	416	206	677	—	—	70	3,394
b)	Snappers	—	8	2,133	722	3	153	—	8	352	717	—	68	101	4,265
c)	Pig-face breams	—	5	6	1,655	13	43	19	—	8	112	—	—	—	1,861
d)	Threadfin breams	—	466	2,147	2,883	317	20,439	1,525	1,055	4,682	4,258	—	—	94	37,866
e)	Other perches	88	202	6,820	5,068	488	5,755	655	161	598	2,924	864	137	125	23,855
10.	Goat fishes	—	90	948	1,758	43	75	1	—	916	319	—	24	20	4,194
11.	Threadfins	71	45	2,130	475	23	453	13	1	500	3,846	41	—	5	7,603
12.	Croakers	2,976	16,903	8,047	12,707	741	9,686	2,005	1,677	22,588	31,877	30	—	695	1,09,852
13.	Ribbon fishes	5,654	1,235	6,457	11,903	215	6,464	733	479	11,612	7,972	—	—	361	53,085
14.	Carangids														
a)	Horse mackerel	47	314	764	62	—	188	287	371	512	982	—	—	8	3,535
b)	Scads	4	37	1,897	2,611	801	5,699	1,530	139	—	—	—	—	1	12,719
c)	Leather-jaeckets	39	146	1,967	1,603	37	225	1,446	—	1,020	2,641	—	—	—	9,124
d)	Other carangids	11	443	3,158	10,395	933	7,560	4,272	1,481	3,938	648	505	45	46	33,435
15.	Silver bellies	95	363	5,035	39,912	925	3,911	3,355	1,669	1,016	456	381	—	4	57,122
16.	Big-jawed jumper	—	18	594	834	—	1,645	852	786	2,475	7,317	—	—	—	14,521

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17.	Pomfrets														
	a) Black pomfret	278	295	6,371	716	133	735	1,181	125	2,716	3,269	7	—	5	15,381
	b) Silver pomfret	2,396	2,020	3,437	352	37	656	543	231	16,476	7,914	30	—	27	34,119
	c) Chinese pomfret	—	—	61	1	—	222	53	30	—	112	—	—	—	479
18.	Mackerels														
	a) Indian mackerel	32	396	6,412	6,540	951	11,676	12,337	2,684	985	52	480	—	—	42,545
	b) Other mackerels	—	17	—	—	—	—	1	—	—	—	85	—	—	103
19.	Seer fishes														
	a) *S. commerson*	109	221	2,696	5,800	282	3,255	4,149	41	1,661	144	165	26	103	18,652
	b) *S. guttatus*	140	792	5,333	386	11	2,976	771	325	3,096	3,712	155	33	—	17,730
	c) *S. lineolatus*	—	3	43	165	—	13	1	—	—	—	—	—	—	225
	d) *Acanthocybium* spp.	—	—	—	44	—	—	—	—	—	—	—	—	—	44
20.	Tunnies														
	a) *E. affinis*	2	11	811	1,702	59	4,203	795	115	2,660	1,418	—	44	—	11,820
	b) *Auxis* spp.	—	20	10	216	—	1,397	128	—	—	—	—	—	—	1,771
	c) *K. pelamis*	—	—	8	26	—	5	—	—	—	—	170	3,365	—	3,574
	d) *T. tonggol*	—	—	1	157	—	34	28	—	—	—	—	—	—	220
	e) Other tunnies	29	—	36	460	32	530	162	35	152	584	45	904	—	2,969
21.	Bill fishes	—	—	66	246	15	319	6	214	184	18	154	42	—	1,264
22.	Barracudas	—	25	158	1,843	74	1,109	12	24	215	65	213	14	9	3,761
23.	Mullets	11	1	93	423	3	69	42	93	59	2,384	244	—	—	3,422
24.	Unicorn cod	—	—	—	—	—	—	—	—	2,650	—	—	—	—	2,650
25.	Flat fishes														
	a) Halibut	—	—	100	111	37	59	1	—	554	456	—	—	9	1,327
	b) Flounders	—	—	27	33	—	2	—	—	—	—	—	—	13	75
	c) Soles	38	327	470	1,570	283	17,745	6,032	2,313	4,524	6,336	—	—	—	39,638
26.	Crustaceans														
	a) Penaeid prawns	2,304	2,048	8,787	15,154	854	35,529	5,511	4,853	43,934	10,848	199	—	30	1,30,051
	b) Non-penaeid prawns	10,735	21	1,183	1,453	63	738	—	—	39,230	8,536	2	—	—	61,961
	c) Lobsters	—	1	12	566	5	53	3	6	963	1,604	9	—	1	3,223
	d) Crabs	111	103	1,889	8,586	736	505	476	1,032	790	14,450	30	—	—	28,708
	e) Stomatopods	23	47	585	654	—	7,055	9,838	4,702	1,838	4,110	—	—	—	28,852
27.	Cephalopods	42	59	450	3,694	37	5,422	333	408	7,650	2,312	—	14	543	20,964
28.	Miscellaneous	1,731	709	1,890	20,476	1,321	7,576	1,762	3,713	5,657	14,552	358	251	420	60,416
	TOTAL	39,923	46,578	1,46,694	2,52,120	14,941	3,93,472	1,26,996	38,505	3,06,285	2,50,590	6,226	5,331	3,017	16,30,678

Table 12. *Estimated marine fish landings in India during 1984–'85 (figures in tonnes)*

Sl. No.	Name of fish	West Bengal	Orissa	Andhra Pradesh	Tamil Nadu	Pondi-cherry	Kerala	Karna-taka	Goa	Maha-rashtra	Gujarat	Anda-mans*	Laksha-dweep	Larger trawlers	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Elasmobranchs														
a)	Sharks	127	1,327	7,298	2,372	145	5,300	1,428	398	6,812	8,481	302	180	45	34,215
b)	Skates	132	46	600	167	—	21	—	—	1,087	638	38	—	—	2,729
c)	Rays	128	307	2,610	8,557	146	1,165	88	166	1,941	2,825	31	97	—	18,061
2.	Eels	24	155	755	245	1	13	1	4	3,051	3,663	—	—	50	7,962
3.	Cat fishes	1,939	5,903	5,477	2,902	67	10,487	2,746	1,908	11,070	9,642	125	—	24	52,290
4.	Clupeids														
a)	Wolfherring	341	840	1,866	2,771	80	1,326	543	164	5,256	5,163	73	—	1	18,424
b)	Oil sardine	—	539	164	1,339	358	1,28,239	31,963	2,025	910	—	—	—	—	1,65,537
c)	Other sardines	14	4,370	20,975	26,053	2,271	5,055	4,900	2,488	283	680	1,125	—	—	68,314
d)	Hilsa shad	6,250	1,634	57	567	—	212	18	—	514	249	108	—	—	9,609
e)	Other shads	297	205	3,444	3,256	163	32	6	2	2,533	5,024	—	—	—	14,962
f)	Anchovies														
	Coilia	487	916	119	513	17	—	—	8	12,448	9,764	—	—	—	24,272
	Setipinna	617	1,255	7	26	—	—	1,324	—	—	—	—	—	—	3,229
	Stolephorus	13	698	3,293	14,675	458	41,363	11,684	268	120	—	120	—	—	72,692
	Thryssa	41	5	3,868	7,873	911	1,330	1,085	1,406	1,709	1,853	99	—	—	20,180
g)	Other clupeids	1,266	2,607	9,764	5,876	722	5,262	5,004	509	4,194	7,820	—	—	—	43,024
5.	Bombay duck	2,048	303	912	4	—	—	—	—	61,256	60,424	—	—	—	1,24,947
6.	Lizard fishes	—	160	1,172	2,134	144	6,991	397	514	2,058	1,207	—	—	87	14,864
7.	Half beaks & Full beaks	1	—	150	945	3	250	116	34	44	15	102	65	—	1,725
8.	Flying fishes	—	1	38	2,199	451	—	1	—	—	—	—	9	—	2,699
9.	Perches														
a)	Rock cod	—	1	18	1,277	11	312	63	621	262	577	—	—	12	3,154
b)	Snappers	—	11	2,828	705	2	112	—	1	407	406	—	49	30	4,551
c)	Pig-face breams	—	61	6	1,473	3	76	19	1	7	123	—	—	—	1,769
d)	Threadfin breams	—	255	1,592	2,542	299	22,108	1,383	963	3,970	5,143	—	—	61	38,316
e)	Other perches	95	359	7,049	4,740	530	6,105	483	249	510	3,249	919	100	16	24,404
10.	Goat fishes	—	405	996	1,757	36	37	1	—	853	417	—	24	14	4,540
11.	Threadfins	66	98	2,376	417	20	422	13	—	802	4,251	42	—	3	8,510
12.	Croakers	1,493	18,438	7,659	9,987	690	9,799	1,589	2,152	20,195	36,426	30	—	214	1,08,672
13.	Ribbon fishes	4,773	1,262	5,982	12,149	97	6,557	702	1,125	10,461	9,132	—	—	78	52,318
14.	Carangids														
a)	Horse mackerel	47	347	1,593	62	—	172	250	381	537	927	—	—	—	4,316
b)	Scads	4	39	429	2,269	801	5,255	1,530	139	1,068	—	—	—	—	11,534
c)	Leather-jackets	28	161	1,468	3,874	26	173	1,469	6	3,527	2,783	—	—	—	13,515
d)	Other carangids	10	384	2844	10,121	933	7,485	4,369	667	—	636	530	44	2	28,025
15.	Silver bellies	133	566	4,632	35,802	878	3,783	3,323	1,220	935	457	425	—	3	52,157
16.	Big-jawed jumper	—	33	629	846	—	1,537	836	874	1,894	12,007	—	—	—	18,656
17.	Pomfrets														
a)	Black pomfret	318	257	2,270	706	128	763	1,180	144	2,409	3,310	7	—	2	11,494
b)	Silver pomfret	1,882	1,873	2,794	334	38	629	308	237	15,251	11,261	32	—	—	34,639
c)	Chinese pomfret	—	—	15	1	—	216	53	33	—	128	—	—	—	446

* Provisional

1		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
18.		Mackerels														
	a)	Indian mackerel	37	332	4,497	4,891	920	12,937	12,775	2,707	744	81	490	—	—	40,411
	b)	Other mackerels	—	17	—	—	—	—	—	—	—	—	87	—	—	104
19.		Seer fishes														
	a)	*S. commerson*	14	197	2,019	5,517	257	3,343	4,100	42	1,310	527	170	23	29	17,548
	b)	*S. guttatus*	108	596	3,126	429	12	3,148	682	404	3,430	4,094	160	29	—	16,218
	c)	*S. lineolatus*	—	3	11	168		4	—	—	—	—	—	—	—	186
	d)	*Acanthocybium* spp.	—	—	—	44	—	—	—	—	—	—	—	—	—	44
20.		Tunnies														
	a)	*E. affinis*	2	62	10	1,005	59	4,376	445	115	2,615	2,651	—	49	—	11,389
	b)	*Auxis* spp.	—	24	—	56	—	1,216	112	—	112	5	—	—	—	1,525
	c)	*K. pelamis*	—	—	8	26	10	4	—	—	—	41	172	3,778	—	4,039
	d)	*T. tonggol*	—	—	—	128	—	33	25	—	—	—	—	—	—	186
	e)	Other tunnies	29	2	978	497	32	499	194	35	—	—	46	1,015	—	3,327
21.		Bill fishes	—	—	209	329	15	285	5	214	183	44	156	41	—	1,481
22.		Barracudas	—	49	341	1,724	85	1,081	13	35	262	86	216	13	2	3,907
23.		Mullets	10	—	230	468	2	81	43	152	57	3,006	261	—	—	4,310
24.		Unicorn cod	—	—	—	—	—	—	—	—	2,569	—	—	—	—	2,569
25.		Flat fishes														
	a)	Halibut	—	—	87	108	18	17	2	85	528	885	—	—	3	1,733
	b)	Flounders	—	—	33	42	—	—	—	—	—	—	—	—	—	75
	c)	Soles	36	500	426	1,354	293	18,447	6,347	3,732	4,812	6,704	—	—	—	42,651
26.		Crustaceans														
	a)	Penaeid prawns	1,034	2,496	7,647	12,567	711	37,168	5,547	3,903	45,416	13,787	206	—	58	1,30,540
	b)	Non-penaeid prawns	7,989	23	1,240	1,448	62	719	—	—	51,882	10,599	2	—	—	73,964
	c)	Lobsters	—	1	10	520	5	96	—	18	1,529	1,062	9	—	—	3,250
	d)	Crabs	89	137	1,591	8,207	715	664	389	1,478	689	12,499	30	—	—	26,488
	e)	Stomatopods	20	110	523	433	—	6,182	8,125	7,477	2,354	4,392	—	—	—	29,616
27.		Cephalopods	13	92	387	3,457	42	7,170	285	452	8,625	3,328	—	13	232	24,096
28.		Miscellaneous	899	686	1,743	17,644	1,273	7,418	1,658	1,965	5,047	16,259	374	265	113	55,344
		TOTAL	32,854	51,148	1,32,865	2,32,598	14,940	3,77,475	1,19,622	41,521	3,10,538	2,88,731	6,587	5,794	1,079	16,15,752

Visakhapatnam Outer Harbour

The total landings from trawlers during 1983–'84 showed an increase of about 3,100 tonnes. The number of operations recorded a corresponding increase of about 7,000, the catch per operation registering an increase from 197 kg in 1982–'83 to 248 kg in 1983–'84. Among the commercially important varieties, penaeid prawns and ribbon fishes showed an increase of about 400 tonnes each and perches about 1,400 tonnes.

The landings by trawlers in 1984–'85 showed a reduction of about 2,000 tonnes from 8,300 tonnes of the previous year. The number of operations also registered a reduction of about 2,200 while the catch per operation decreased to 203 kg from 248 kg of previous year. Among the commercially important varieties, perches reduced by 900 tonnes, silver bellies by 200 tonnes and penaeid prawns by 200 tonnes.

Kakinada Fisheries Harbour

The landings by trawlers in Kakinada Fisheries Harbour during 1983–'84 showed an increase of about 3,200 tonnes over 16,200 tonnes of 1982–'83. The number of operations correspondingly increased by about 6,000 as compared to previous year. The catch per operation registered an increase from 384 kg of 1982–'83 to 402 kg of 1983-'84. Among the commercially important varieties, non-penaeid prawns showed an increase of 1,400 tonnes, silver bellies increased by about 1,100 tonnes, croakers by 600 tonnes, ribbon fishes by 600 tonnes and penaeid prawns by 300 tonnes. However, scads showed a decline by about 1,300 tonnes.

The landings by trawlers in 1984–'85 have shown a reduction in the landings by about 5,300 tonnes from 19,400 tonnes of 1983–'84 to 13,100 tonnes in 1984–'85. The number of operations also has shown a steep reduction by about 11,700 but catch per operation reduced to 387 kg from 402 kg of 1983–'84. Among the commercially important varieties, the landings of non-penaeid prawns decreased by about 1,900 tonnes. The landings of perches reduced by about 1,000 tonnes, that of penaeid prawns by 600 tonnes, silver bellies by 600 tonnes and scads by 800 tonnes.

Pudumanaikuppam

The landings by trawlers in 1983–'84 increased marginally by about 200 tonnes from that of 1982-'83. About 99% of landings by mechanised crafts at Pudumanaikuppam came from trawlers and the remaining from gill netters. The number of operations showed a reduction of about 4,700 in respect of trawlers and 500 in respect of gill netters. Catch per operation increased from 263 kg in 1982-'83 to 311 kg in 1983-'84 in respect of trawlers and from 115 kg of 1982–'83 to 130 kg in 1983–'84 in respect of gill netters. Among the commercially important varieties, the landings of penaeid prawns reduced by 400 tonnes, perches by 300 tonnes and lizard fishes by 400 tonnes. However, silver bellies increased by 200 tonnes, scads by 200 tonnes and croakers about 200 tonnes.

The landings by trawlers decreased in 1984–'85 compared to previous year by about 400 tonnes and that of gill netters increased by about 200 tonnes. 96% of mechanised landings was contributed by trawlers. The number of operations of trawlers and gill netters increased in 1984–'85 by about 7,000 and 800 respectively. Catch per operation in 1984–'85 in respect of trawlers reduced from 311 kg of 1983–'84 to 241 kg and that of gill netters increased from 131 kg to 206 kg. Among the commercially important varieties from trawlers, perches showed a decrease by about 700 tonnes, silver bellies reduced by 300 tonnes and penaeid prawns by about 400 tonnes. However, the landings of elasmobranchs increased by about 500 tonnes and lizard fishes increased by 600 tonnes.

Cuddalore Fisheries Harbour

Landings by trawlers recorded an increase of about 1,000 tonnes during 1983–'84 compared to that in the previous year. The landings by gill netters, however, showed reduction by 1,500 tonnes. About 92% of the total landings was contributed by trawlers. The number of operations increased by about 2,000 in respect of trawlers but reduced by about 3,100 in respect of gill netters. Catch per operation in respect of trawlers increased from 253 kg of 1982–'83 to 301 kg in 1983–'84. In respect of gill netters, catch per operation decreased from 411 kg of 1982–'83 to 248 kg in 1983–'84. Among the commercially important varieties of fish from trawlers, silver bellies increased by about 600 tonnes. In the landings by gill netters, sharks decreased by 400 tonnes, seer fishes decreased by about 600 tonnes and tunnies by about 400 tonnes.

The landings by trawlers in 1984–'85 showed a decrease of about 800 tonnes from that of the previous year. Number of operations reduced by about 2,000. Catch per operation also reduced from 301 kg of 1983–'84 to 285 kg in 1984–'85. The landings by gill netters did not show any appreciable difference from the previous year's landings nor the number of operations.

Among the commercially important varieties of fish from trawlers, silver bellies recorded a reduction by about 600 tonnes.

Nagapattinam

The landings by trawlers in 1983–'84 registered an increase of about 6,000 tonnes compared to that in the previous year. The number of operations also showed an increase of 11,800. The catch per operation increased from 323 kg of 1982–'83 to 376 kg in 1983–'84. Among the commercially important varieties, silver bellies increased by about 2,100 tonnes, croakers by 700 tonnes and penaeid prawns by 800 tonnes.

The landings by trawlers in 1984–'85 reduced to about 8,900 tonnes from 12,900 of 1983–'84 showing a decrease of about 4,000 tonnes. But number of operations showed an increase of about 7,600. Catch per operation decreased from 376 kg of 1983–'84 to 216 kg in 1984–'85. Among the major varieties, penaeid prawns showed a decrease in the landings by about 500 tonnes, croakers decreased by 500 tonnes, silver bellies by about 1,300 tonnes and perches by about 500 tonnes.

Mandapam Camp

Landings in 1983–'84 by trawlers showed an increase of about 600 tonnes over that of the previous year. The number of operations increased by about 8,700 but the catch per operation showed a decrease from 140 kg of 1982–'83 to 129 kg in 1983–'84. Silver bellies showed a decrease in the landings by about 700 tonnes but penaeid prawns showed a marginal increase of about 100 tonnes.

Landings by trawlers in 1984–'85 registered an increase of about 300 tonnes over that of the previous year. The number of operations showed an increase of 5,500. Catch per operation, however, showed a marginal decrease from 129 kg of 1983–'84 to 123 kg in 1984–'85. Among the commercially important varieties, penaeid prawns showed an increase of about 200 tonnes but silver bellies reduced in landings by about 500 tonnes and crabs recorded an increase of about 500 tonnes.

Rameshwaram

The landings by trawlers at Rameshwaram during 1983–'84 registered an increase of about 4,300 tonnes from about 22,800 tonnes of 1982–'83. The number of operations increased by about 3,400 and catch per operation increased from 241 kg of 1982–'83 to 276 kg in 1983–'84. Among the major varieties of fish, silver bellies increased by about 1,700 tonnes, rays by 900 tonnes and penaeid prawns by 500 tonnes.

The landings by trawlers in 1984–'85 showed a decrease of about 5,600 tonnes. The number of operations decreased by about 22,700 but catch per operation increased from 276 kg of 1983–'84 to 285 kg in 1984–'85. Silver bellies showed a decrease of about 4,000 tonnes, croakers about 1,000 tonnes and rays about 400 tonnes.

Tuticorin Fisheries Harbour

The landings by trawlers in 1983–'84 at Tuticorin Fisheries Harbour recorded an increase of about 3,600 tonnes over the corresponding landings of the previous year. The number of operations of trawlers recorded increase in 1983–'84 by about 15,700. The catch per operation reduced from 382 kg of 1982–'83 to 324 kg in 1983–'84. The landings of silver bellies showed an increase of about 600 tonnes, carangids by about 700 tonnes and penaeid prawns by about 300 tonnes.

The landings by trawlers in 1984–'85 showed an increase of about 2,400 tonnes from 13,100 tonnes of the previous year. The number of operations increased by 11,400 and catch per operation decreased from 324 kg of 1983–'84 to 299 kg in 1984–'85. Among the commercially important varieties, silver bellies showed an increase of 1,900 tonnes over that of previous year and penaeid prawns increased by about 1,000 tonnes.

Sakthikulangara

The landings by the mechanised boats at Sakthikulangara during 1983–'84 increased by about 2,100 tonnes over that of the previous year. The landings by trawlers which accounted for 92% of total landings by the mechanised crafts showed an increase of about 700 tonnes. The landings by gill netters registered an increase of about 1,100 tonnes from 1,700 tonnes of the previous year. The number of operations of trawlers decreased by 18,000 while that of gill netters increased by 1,600. The catch per operation in respect of trawlers increased from 263 kg of 1982–'83 to 312 kg in 1983–'84. Catch per operation realised by gill netters in 1983–'84 was 179 kg against 121 kg of 1982–'83. Among the major varieties of fish, penaeid prawns showed a decrease of about 1,200 tonnes from 9,400 tonnes of the previous year. However, the landings of perches showed an increase of about 1,400 tonnes and that of croakers

1,200 tonnes. In the landings by gill netters tunnies showed an increase of about 700 tonnes.

The landings by the mechanised boats at Sakthikulangara during 1984–'85 recorded an increase of about 24,700 tonnes over that of the previous year. The landings by trawlers accounting for 94% of the total landings by the mechanised boats showed an increase of about 24,000 tonnes. The number of operations of trawlers increased by about 19,000 and that of gill netters increased by about 1,200. The catch per operation realised by trawlers increased from 312 kg of 1983–'84 to 452 kg of 1984–'85. The catch per operation realised by gill netters in 1984–'85 was 221 kg against 179 kg of 1983–'84. Among the commercially important varieties from trawlers, perches increased by about 10,700 tonnes, penaeid prawns by 6,400 tonnes, croakers by 1,200 tonnes and lizard fishes by 1,700 tonnes. In the landings by gill netters, seer fishes showed an increase of 500 tonnes but tunnies showed a decrease by about 200 tonnes.

Cochin Fisheries Harbour

The landings by the mechanised boats in 1983–'84 increased by 4,400 tonnes over about 21,000 tonnes of 1982–'83. Trawlers accounted for 35% and purse seiners 56%. The landings by trawlers showed a decrease of about 400 tonnes in 1983–'84 from 9,300 tonnes of the previous year. The number of operations correspondingly decreased by about 3,800. But the catch per operation realised by trawlers showed a marginal increase from 191 kg in 1982–'83 to 198 kg of 1983–'84. Landings by purse-seiners showed an increase of 4,800 tonnes in 1983–'84 over that of the previous year but the number of operations showed a reduction by about 1,200. Catch per operation increased from 1,155 kg of 1982–'83 to 2,041 kg in 1983–'84. The landings by units with power propulsion did not show appreciable difference. However, catch per operation realised by gill netters in 1983–'84 showed an increase from 118 kg of 1982–'83 to 133 kg. Among the commercially important varieties, oil sardine increased by 5,500 tonnes from 6,500 of 1982–'83 and penaeid prawns showed an increase of about 800 tonnes. However, the landings of perches decreased by about 2,200 tonnes.

The landings by the mechanised boats in 1984–'85 showed an increase of about 5,800 tonnes over that of the previous year. The landings by purse seiners accounted for 55% of mechanised landings and showed an increase of about 2,600 tonnes. The landings by trawlers accounted for 36% of the total landings by the mechanised boats and showed an increase of about 2,200 tonnes. The number of operations by purse-seiners showed a decrease of about 800 but the catch per operation increased from 2,041 kg of 1983–'84 to 2,740 kg in 1984–'85. The number of operations by trawlers decreased by 7,900 but the catch realised per operation increased from 198 kg of 1983–'84 to 300 kg in 1984–'85. The catch realised per operation by gill netters decreased from 133 kg of 1983–'84 to 124 kg in 1984–'85. Among the commercially important varieties, perches recorded an increase of about 4,400 tonnes and mackerel increased by 1,500 tonnes. However, the landings of penaeid prawns decreased by 1,600 tonnes.

Mangalore

The total landings by the power propelled crafts in Mangalore during 1983–'84 was estimated at about 28,500 tonnes. The landings by purse-seiners accounted for 67% while the trawlers accounted for 32% and the balance was contributed by gill netters. The catch realised per operation by purse-seiners was 1,964 kg while that by trawlers was 236 kg and by gill netters 120 kg. Oil sardine with 30% formed the major variety of fish landed by mechanised crafts followed by *Stolephorus* spp. with 15%.

In 1984–'85 the landings by the mechanised boats at Mangalore showed an increase of 4,200 tonnes over the landings of the previous year. The landings by purse-seiners which accounted for 83% of the total landings showed an increase of about 8,200 tonnes over the corresponding landings of the previous year while the landings by trawlers showed a decrease of about 3,800 tonnes. The number of operations of purse-seiners showed an increase by about 700 and that of trawlers decreased by about 17,400. Catch per operation realised by purse-seiners during 1984–'85 was 2,608 kg against 1,964 kg of 1983–'84, that of trawlers 249 kg against 236 kg and that of gill netters 99 kg against 120 kg of the previous year. Among the commercially important species, oil sardine showed an increase of about 5,000 tonnes and mackerel by 2,900 tonnes.

New Ferry Wharf, Bombay

The landings by trawlers during 1983–'84 increased by about 4,500 tonnes over 37,500 tonnes of 1982–'83. The number of operations increased by about 3,300 but catch per operation by trawlers decreased from 1,703 kg of 1982–'83 to 1,661 kg of 1983–'84. Among the commercially important varieties, penaeid prawns increased by 900 tonnes and elasmobranchs by 1,200 tonnes.

The landings by trawlers in 1984–'85 decreased by 3,400 tonnes from 42,000 tonnes of 1983–'84. The number of operations decreased by about 2,000. The catch per operation realised during 1984–'85 showed a marginal reduction from 1,661 kg of 1983–'84 to 1,658 kg in 1984–'85. Among the commercially important varieties, penaeid prawns showed an increase of about 2,700 tonnes from 9,800 tonnes of 1983–'84. The landings of elasmobranchs decreased by about 3,000 tonnes.

Sassoon Docks, Bombay

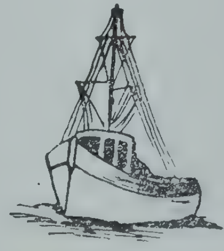
The landings by mechanised crafts in 1983–'84 was estimated at about 30,700 tonnes which showed a reduction in the landings by about 9,600 tonnes compared to the corresponding landings of the previous year. Trawlers contributed 87% of the total mechanised landings, and the balance by 'dol' netters, gill netters and hooks and lines. The landings by trawlers showed a decrease of about 9,100 tonnes in 1983–'84 from that of 1982–'83. The number of operations by trawlers also reduced by about 1,400. The catch realised per operation by trawlers decreased from 1,531 kg of 1982–'83 to 1,213 kg in 1983–'84. The landings by gill netters decreased by 500 tonnes. The number of operations of 'dol' netters increased by about 1,400 and that of gill netters by 400 while for hooks and lines it decreased by about 200. The catch realised per operation by gill netters decreased from 655 kg of 1982–'83 to 450 kg in 1983–'84, that of 'dol' netters decreased marginally from 146 kg of 1982–'83 to 138 kg in 1983–'84 and that of hooks and lines decreased marginally from 238 kg of 1982–'83 to 233 kg in 1983–'84. Among the commercially important varieties, the landings of perches declined by about 1,700 tonnes, cat fishes by about 1,700 tonnes, ribbon fishes by about 1,300 tonnes and croakers by about 900 tonnes.

In 1984–'85 mechanised boats registered an increase of about 9,500 tonnes in landings compared to 30,700 tonnes of the previous year. Landings by trawlers which accounted for 89% of the mechanised landings in 1984–'85 showed an increase by about 9,200 tonnes. The number of operations of trawlers showed a marginal increase of 800 and the catch realised per operation by trawlers increased from 1,213 kg of 1983–'84 to 1,575 kg in 1984–'85. Catch per operation realised by gill netters increased from 450 kg of 1983–'84 to 538 kg in 1984–'85 and that of hooks and lines increased from 233 kg of 1983–'84 to 254 kg in 1984–'85. The catch realised per operation by 'dol' netters did not show appreciable difference in 1984–'85 from that of 1983–'84. Among the commercially important varieties, penaeid prawns increased by 5,400 tonnes and cephalopods by 2,800 tonnes.

Veraval

In Veraval the landings by the mechanised boats during 1983–'84 was estimated at about 40,100 tonnes. The landings by trawlers accounted for 95% of the landings and the remaining by gill netters. The catch per operation realised by trawlers was 1,059 kg and that by gill netters 59 kg. Croakers with 19% formed the major variety of fish followed by big-jawed jumper with 12% and cephalopods and ribbon fish 6% each.

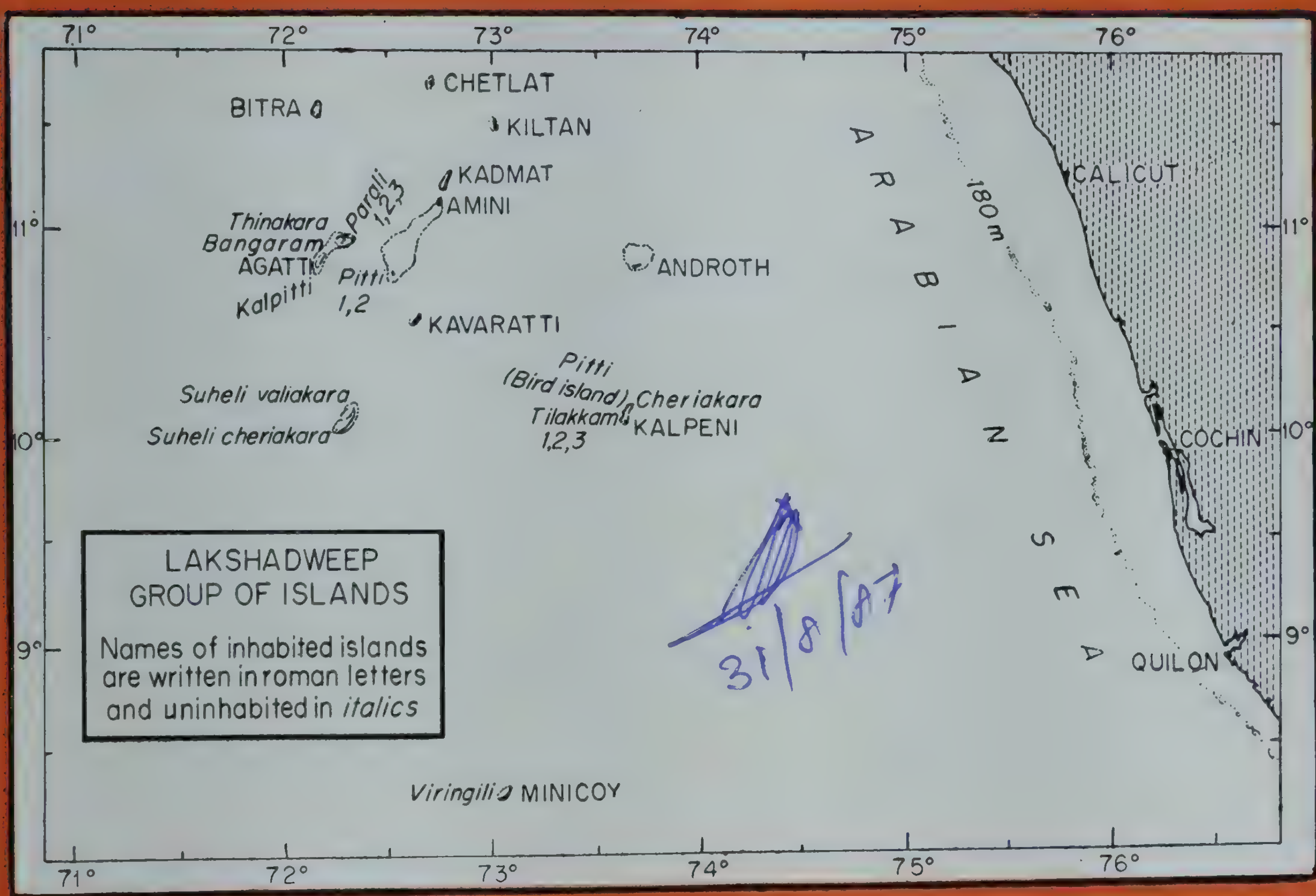
The fish landings by mechanised crafts registered an increase of about 9,500 tonnes in 1984–'85 over the landings of 1983–'84. The landings by trawlers accounting for 91% showed an increase of about 7,700 tonnes and that by gill netters 2,100 tonnes. The number of operations by trawlers and gill netters in 1984–'85 showed an increase of about 1,500 and 8,500 respectively. The catch per operation realised by trawlers in 1984–'85 was 1,214 kg against 1,059 kg of 1983–'84 and that of gill netters was 156 kg against 59 kg of previous year. Landings of penaeid prawns and croakers registered an increase of about 1,700 and 1,800 tonnes respectively while the landings of big-jawed jumper showed a decrease of 2,100 tonnes.



Compiled and prepared by Dr. K. J. Mathew, Shri I. David Raj and Shri D. Vincent. Edited and published by Dr. K. J. Mathew on behalf of the Director, Central Marine Fisheries Research Institute, Cochin-682 031. Printed at PAICO, Cochin-31

MARINE FISHERIES INFORMATION SERVICE

SPECIAL ISSUE ON LAKSHADWEEP



No. 68

JULY, 1986

Technical and Extension Series

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

COCHIN, INDIA

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

THE MARINE FISHERIES INFORMATION SERVICE: Technical and Extension Series envisages the rapid dissemination of information on marine and brackish water fishery resources and allied data available with the National Marine Living Resources Data Centre (NMLRDC) and the Research Divisions of the Institute, results of proven researches for transfer of technology to the fish farmers and industry and of other relevant information needed for Research and Development efforts in the marine fisheries sector.

Abbreviation – *Mar. Fish. Infor. Serv. T & E Ser.*, No. 68: 1986

CONTENTS

Back cover photo:

A coral garden formed of *Acropora* thicket in Minicoy reef-flat. In the foreground many are dead.

PREFACE

The Central Marine Fisheries Research Institute established a research centre in 1958 at Minicoy in Lakshadweep for studying the marine fisheries resources and related environmental features around the island. The centre initially conducted investigations on the fish fauna of the islands and later intensified observations on the tunas and related fishes. As years passed by, the research programmes of the Institute were further enlarged to cover the live-bait fish resources and coral ecology. The work of the centre could not be extended to other islands in view of the lack of infrastructural facilities and man power constraints. However, when required, certain special observations were made by scientists going from the mainland for short periods. As a result of the work done in the past 28 years, a number of scientific papers and reports have been published by the scientists of the Institute.

The present issue of the MFIS is devoted to include a series of articles especially selected to briefly review the marine fisheries research so far conducted in the Archipelago, the present status of various marine fishery resources, the environmental features, the productivity of the sea around the Lakshadweep, the environmental stress and ecological disturbances, the ancillary resources and future prospects for development of marine resources of the islands.

Keeping in view the work that has been done sofar, the Institute identified priority areas for research on tunas, live-bait fishes, conservation of coral reefs and total assessment of marine fishery resources during the Seventh Plan period. The CMFRI has also been actively participating in the meetings concerning the futurology for Lakshadweep and it is hoped that this special issue on Lakshadweep would provide necessary back-stop for perspective planning and development of the living resources of the Lakshadweep. The bibliography on Lakshadweep given at the end of this publication is expected to serve as a ready reference to aid in formulating future programmes for the region.

I deeply appreciate the interest taken by the contributors of various articles in this issue, especially Dr. S. Jones, the former Director of the Institute. Shri T. Jacob and Dr. K. J. Mathew, scientists of this Institute spared no efforts to get together the articles and processing the same through press for which I thank them sincerely.

P. S. B. R. James
Director
Central Marine Fisheries
Research Institute

Cochin - 682 031,
15th July, 1986.

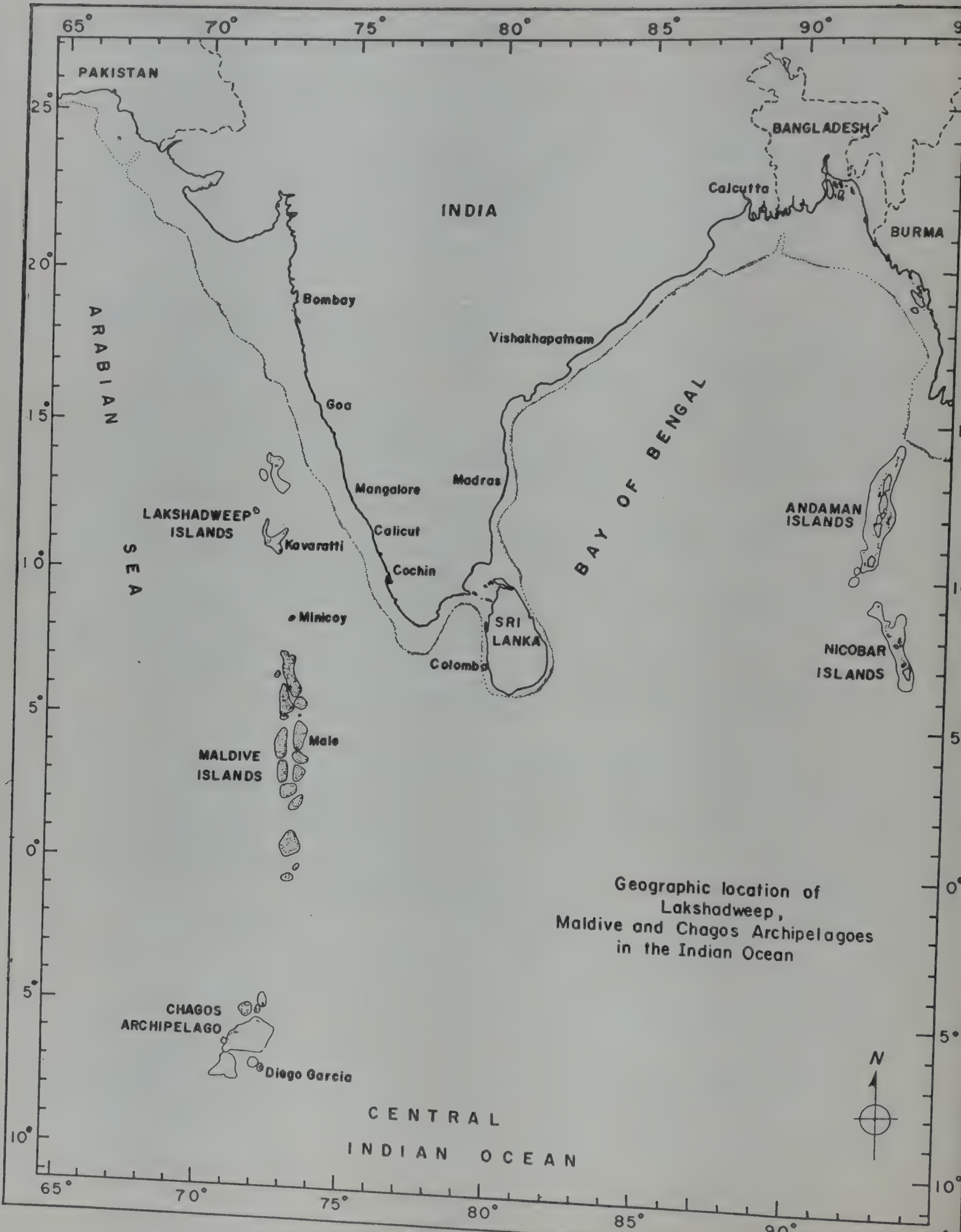

PAKISTAN
INDIA
BANGLADESH
BURMA
Calcutta
Bombay
Vishakhapatnam
ARABIAN SEA
BAY OF BENGAL
Goa
Mangalore
Madras
Calicut
Cochin
LAKSHADWEEP ISLANDS
Kavaratti
Minicoy
SRI LANKA
Colombo
ANDAMAN ISLANDS
NICOBAR ISLANDS
MALDIVE ISLANDS
Male
Geographic location of
Lakshadweep,
Maldive and Chagos Archipelagoes
in the Indian Ocean
CHAGOS ARCHIPELAGO
Diego Garcia
CENTRAL INDIAN OCEAN
N
65°
70°
75°
80°
85°
90°
95°
25°
20°
15°
10°
5°
0°

Fig. 1

LAKSHADWEEP — GENERAL FEATURES AND SOME CONSIDERATIONS

S. Jones*
Rtd. Director, Central Marine Fisheries Research Institute

The Union Territory of Lakshadweep, internationally known as the Laccadives, consists of 10 inhabited islands and 17 uninhabited islets with a total land area of 28.5 sq. km lying between 8° and 12° 30′ N latitudes and 71° and 74° E longitudes. These consist of coral formations built up on a submarine ridge rising steeply from a depth of about 1500 m to 4000 m off the west coast of India. In fact the Laccadive, Maldive and Chagos Archipelagoes form an interrupted chain of coral atols** and reefs on a contiguous submarine bank covering a distance of over 2000km (Fig. 1). Comparatively the Maldives form the largest group among these with about 1100 islands of which 204 are inhabited and having a total land area of 320 sq. km. The population of Maldives is about 1,80,000 as against about 35,000 in Lakshadweep. The Chagos never had any indigenous population and was colonised only in the last century when it formed a part of the Mauritius Administration under the British. It has since been given to the Americans for the establishment of the naval base of Diego Garcia.

The Lakshadweep came under the Central Administration in 1956 with the reorganisation of states on linguistic basis and with it one can rightly say that the area entered into a new phase of progressive development. Till then there was hardly any unified or concerted administration and the islands were under the control of the collectorates of Malabar and South Kanara districts of the erstwhile Madras State, a continuation of the legacy of British suzerainty over these islands that came in two phases, the southern islands in 1792 with the fall of Cannanore and the northern islands in 1799 with the death of Tippu Sultan at the battle of Seringapatnam. The people of the southernmost island of Minicoy are ethnically related to Maldivians and speak the Mahl or Divehi language while the rest speak Malayalam with a characteristic local slang as a result of isolation.

Information in detail about Lakshadweep relating to its geographical features, land fauna and flora, history etc. can be had from Ellis (1924) and Mannadiar (1977). The particulars regarding the inhabited islands are given in Table-1.

The uninhabited islands numbering 17 have a total land area of only 2.3 sq. km and of these Bangaram as a tourist resort and Suheli as a coconut growing and fishing centre are of special interest. Pitti or the bird island is a small reef with a sand bank covering an area of 1.21 hectare lying 24 km northwest of Kavaratti where terns in thousands nest.

The atols** rest on an under water platform of about 100 fathoms deep. Corals cannot grow very deep in the ocean and what we see at present depicts millenia of interaction between the submarine bank, tectonic activity and the level of the ocean, particularly during the Pleistocene period, when a great quantity of water was locked up in continental glaciers. The rims of the atols can grow only to a height which would prevent its exposure during low tides. A reef rimming an atol may be about 300 metres or more across with channels in its perimeter allowing the inflow and outflow of water in the lagoon with the tides. The islands are formed by the accumulation of coral sand in the form of sand bars which eventually get stabilised with vegetation and in course of time get compressed into soft sandstone. Generally the height of land above sea level is about one to two metres, rarely in some places a little more. Some of the islands, subjected to heavy storms, have coral boulders heaped up on one side.

Androth has no lagoon unlike the other atols. Bitra has perhaps the most magnificent lagoon; the island having a land area of only 10.52 hectares. Similarly Minicoy also has a large and deep lagoon, with a

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* Santinivas, Nanthancode, Trivandrum.

** "Atoll" or "atol" is derived from the Divehi (Maldivian) world "*atolu*". According to Bell (1940) the eminent archaeologist who did the pioneer research in the Maldives, the word should be spelt "atol" and not "atoll".

Table 1. *Inhabited Islands (Alphabetically arranged)**

Sl. No.	Name	Geographic location	Distance from Cochin in nautical miles	Area in sq. km	Population (1971 census)	Language
1.	Agatti	Lat. 10° 51′ N Long. 72° 11′ E	248	2.7	3155	Malayalam
2.	Amini	Lat. 11° 07′ N Long. 72° 44′ E	220	2.6	4542	,,
3.	Androth	Lat. 10° 49′ N Long. 73° 41′ E	158	4.8	5425	,,
4.	Bitra	Lat. 11° 36′ N Long. 72° 10′ E	261	0.1	112	,,
5.	Chetlat	Lat. 11° 41′ N Long. 72° 43′ E	233	1.0	1200	,,
6.	Kadmat	Lat. 11° 13′ N Long. 72° 47′ E	220	3.1	2416	,,
7.	Kalpeni	Lat. 10° 05′ N Long. 73° 39′ E	155	2.3	3152	,,
8.	Kavaratti	Lat. 10° 33′ N Long. 72° 38′ E	213	1.6	4420	,,
9.	Kiltan	Lat. 11° 29′ N Long. 73° E	218	3.6	2046	,,
10.	Minicoy	Lat. 8° 17′ N Long. 73° 04′ E	215	4.4	5342	Mahl (Divehi)

boat channel on the north-eastern side giving safe access and anchorage to vessels of about 3 m draught.

The outer edges of the atols drop precipitously to the ocean floor. Mostly on the eastern side, the outer edge of the atol overhangs the precipitous shelf. The eastern side is generally more sheltered from wind and current facilitating anchoring of vessels.

Availability of drinking water is the most essential requirement for the colonisation of the islands. The rainfall is a little more in the south than in the north showing an average of about 1,640 mm for Minicoy and 1,504 mm for Amini. The rainiest months are from June to September with June receiving the maximum amount. The rain-water sinks into the porous sand of the islands to form a subsurface layer of fresh water lens which is utilised by digging small wells about 2 to 3 metres deep.

* The area of Androth is given as 4.8 sq km. and that of Minicoy as 4.4 sq. km. Minicoy is considered the largest of the islands in the Laccadive Archipelago with an area of 1,120 acres with Androth coming next with an area of 1,067 acres (Ellis 1924). It therefore remains to be checked if the areas given for the two islands in the gazetteer should be interchanged.

The climate is more or less comparable to that of the coastal areas of Kerala, warm and humid but bearable. Maximum temperature may range from 35°C to 38°C and the minimum may come down to 17°C to 18°C. Occasionally cyclonic storms occur, the oldest and the most serious recorded being the one that struck Kalpeni and Androth on April 15, 1847. The subsequent ones were in 1891, 1922, 1948, 1963 and 1965 but never of the magnitude of the first one.

The mineral resources of the islands consist of low grade phosphates, derived out of bird droppings before the islands were colonised by man, and calcium carbonate sands. Exploitation of these are linked with the very existence of these islands and any attempt made in this direction should not turn out suicidal.

The two most important items coming under the flora and fauna of the islands are the coconut and fishes which form the mainstay of the people of the islands. Coconuts form the real tree of life of the islanders and every part of it is of use to them in one way or other. There are several kinds of plants in the islands but none

of such importance as the coconut tree. No cereal of any significant importance is grown in the islands. Plantains and a variety of ordinary vegetables are grown for home use. There are some trees like jack, mango, breadfruit, Indian laurel, portia etc. The drumstick plant is widely distributed. Tubers and underground stems like tapioca, yam and colocasia, gourds, legumes etc are cultivated in small quantities for local use. A variety of wild herbs and shrubs grow and new plants are occasionally introduced from the mainland. The area available is so limited and the population is registering such a steady increase that there is very little space for any large scale cultivation. Further, there is limitation regarding availability of water for any extensive agricultural operations.

Until the territory came under Central Administration, large scale fishing was in vogue only in Minicoy. Within the last quarter of a century remarkable strides have been made in fishery development. The Central Marine Fisheries Research Institute has made a comprehensive study of the fish fauna of the entire Archipelago (Jones & Kumaran, 1980). The progress made in fishery development will be dealt with in detail by the concerned persons elsewhere in this volume. There is no land fauna of any special importance except perhaps the tree rat which is of a very destructive nature.

The people there are all muslims who are very devoted to their religion. They are very peace loving, and criminal records are few and far between, perhaps the lowest in the Indian Union. Till it became a Union Territory no permanent police force was stationed in the islands. Records of criminal assaults are reported to be very few and murders are practically unknown, perhaps one in a few decades. However, their propensity to litigation is said to be rather high, an outlet for their emotions being probably found in this sort of diversion! A certain type of caste system was in existence evidently based on their background as migrants from India before islamisation. The social structure in Minicoy bears close affinities with that in the Maldives. The *Athiri* or the village system is of a special kind there and the women there have a very dominant position in the society, perhaps unlike anywhere else among the Muslims. Even in ancient days it had a special status and was reported to have been ruled by queens. The inhabitants of all the other islands are migrants from Kerala several centuries ago. Maloney (1980) after a comprehensive study of the social conditions in the Maldives has compared the same with those of Lakshadweep. This and the publication by Kutty (1972) may be referred for details.

General remarks

Having had the opportunity to visit all the inhabited islands in Lakshadweep and make a general study of the conditions there, I take the liberty of offering some general remarks as my personal views for the consideration of the planners who contemplate to develop the economy of these islands in the coming years. The 27 islands ranging in area from about a hectare to nearly 5 sq. km have total land area of only 28.5 sq.km forming nothing but little specks in the Indian Ocean, with a water spread of over 73 million sq.km. The tiny bits of land rising hardly 2 m above sea level has perhaps the most mysterious origin covering millions of years owing to a continuous process of growth, destruction and consolidation, involving millions of tiny organisms, mostly colonial. The submarine bank that supports the atols rise from depths ranging from 1,500 metres to 4,000 metres. In short the islands arise more or less steeply from great depths. The particulars of the great cyclonic storm of April, 1847 that hit Kalpeni and Androth as stated briefly in the Gazetteer (Mannadiar, 1977) are given below.

"...It commenced in Kalpeni about 8 P.M. on 15th April, passed to Androth and finally reached Kiltan after devastating these two islands. All the houses in Kalpeni were damaged and many were entirely washed away. The population of that island prior to the hurricane was reckoned at 1,642. Of these, 246 were drowned or washed away by the storm. One hundred and twelve perished in the ensuing five months from famine or from the diseases engendered by unwholesome and insufficient food, 376 escaped to the coast, leaving in the island 908, of whom nearly four-fifths were women and children. The plantations in the island were completely destroyed. Cut of upwards of 1,05,000 full grown coconut trees, the number before the storm, only 768 survived. In Androth, the population before the storm was 2,576. Many people perished in the storm and large numbers of the survivors migrated to other islands. Those left in the island numbered only 900. The coconut trees were almost completely destroyed".

The above will give an idea of the conditions of existence of these islands. They are beautiful, idyllic and exhilarating but once any rise happens to the sea level - a mere metre and a half - the yawning and precipitous sea bottom is the fate! We have to bear in mind the above fact while planning.

Development of cottage industries, I am sure, will receive the attention of planners and these are therefore,

left to the experts in the field. However, in this connection, it would be necessary to bear in mind the availability of the well disciplined and hardworking women folk of the islands who form a potential labour force of great importance.

The land and the resources available therein being very limited we have necessarily to look towards the sea around the islands for further development. There is a vast expanse of oceanic waters and it is best that we think of the optimum utilisation of the resources therein. As already stated the progress made in fishery development by the Lakshadweep Administration is appreciable. Pole and line fishing with live-bait has been extended to all the islands while previously it was confined only to Minicoy. Sea is an area from where we can harvest without sowing. The living resources therein are of the renewable category under proper management, though not inexhaustible in the strict sense. He who takes it gets it. It is the property of all or *res communis* and at the same time the property of none or *res nullius*. According to international convention each country has its right over its territorial waters and exclusive economic zone (EEZ). The Lakshadweep Sea is estimated to have an annual fishery potential of about 90,000 tonnes while the present yield as per statistics of 1984 is reported to have reached only about 5,000 tonnes a year. This gulf has necessarily to be narrowed till an optimum level of catch is reached. It is needless to say that there are constraints for achieving this. As usual it is a chain of requirements, one affecting the other. Some of the major ones are availability of live-bait, man power, craft and gear and adequate infrastructure facilities on the shore. At present the skipjack catch which forms the major fishery is almost entirely dependent on the availability of live-bait fish. Long line brings in the other tuna and related fishes apart from sharks and some pelagic fishes. The fishing as practised now is bound to limit the catches at more or less the present level unless a break-through is made.

We have not been successful in purse seining for skipjack. However, it is reported that a very successful purse seine fishery has been built up in Seychelles mainly by the French, but also Spanish, Ivory Coast and British vessels raising the catch from 1,000 tonnes in 1981 to 1,00,000 tonnes in 1984. The catches consist mainly of skipjack and yellow fin. If things are to continue at this rate the repercussions it will have on the tuna stocks in the Indian Ocean are quite obvious. Tunas are highly migratory fishes. Nature does not allow a vacuum to exist in the biological complex of the ocean. It is only natural that tuna shoals from the surrounding areas should migrate to the intensively fished zone where more abundant food should become available. As the fishing range increases, tuna stocks in a progressively wider area will get affected by a gradual process of thinning out. It is therefore felt that a complete reorientation in the development programme of our oceanic fisheries is called for to be taken up at national level. This will enable the islands to be used as a reconnoitering base and a springboard for a greater expansion of our fishing range. Fishing being a concurrent subject it is only appropriate that the development of the same in Lakshadweep and surrounding areas is taken as a national problem.

The adjacent Republic of Maldives where the skipjack fishery constitutes the mainstay of the islanders, the current annual catch is 60,000 tonnes. It is steadily on the increase. The coral reefs and atols there are quite extensive and support live-bait fishes of considerable magnitude, perhaps unknown anywhere else. Their mainstay is *Spratelloides japonicus* and *S. delicatulus* followed by *Lepidozygus tapeinosoma* and a variety of small fishes caught from the vicinity of reefs and from lagoons. Survival of certain species in bait-wells is a problem and experimental research to mitigate this disadvantage is called for. It is desirable that we keep a close watch and make a study of the work done elsewhere for solving similar problems.

It has been said that some visitors to these islands seeing the beautiful and peaceful set up there give vent to their feelings, in their enthusiasm, in terms of air strips, helipads, factories etc without taking into consideration the existing limitations of space, man power, local resources etc. These ideas might even tend to appear exciting and plausible to many of the innocent local people who would not have understood properly what these would ultimately lead to. At the same time we hear the cry for the need to protect the ecological and environmental conditions there which for obvious reasons are very delicately poised by nature. These islands are nature's precious gifts and it is left to us to look after and develop them with the utmost care and foresight without destroying them.

MARINE FISHERIES RESEARCH IN LAKSHADWEEP – A HISTORICAL RESUME

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The Lakshadweep

The Lakshadweep is located on the Laccadive-Chagos ridge which is supposed to be the continuation of the Aravali mountains, and the islands are believed to be the remnants of the submerged mountain cliffs. The archipelago is composed of 22 islands and 5 attached islets scattered between latitudes 08°00′ N and 12°30′N and between longitudes 71°00′E and 74°00′E. Except Androth, all the islands have a lagoon, some of which, as in Kiltan and Minicoy, are fast getting filled up by calcareous sand. Only ten islands are inhabited. Coconuts and tuna are the mainstay of the economy of this Union Territory. The vast stretches of blue waters around the islands are rich in tunas which are exploited by both mechanised and non-mechanised vessels which use pole and line method with the help of live–baits.

The history of the fishery of Lakshadweep should be as old as the history of human settlement in these tiny tots of islands. The marine biological and fishery research in the Lakshadweep Sea dates back to the end of the 19th century, when the surgeon naturalist A. Alcock set sail on 17th October, 1891 by R.M.S. *Investigator*. For two months he cruised in the Lakshadweep Sea, "sketching and checking the position of the islands, running lines of deep-sea soundings and occasionally taking a turn with the deep-sea dredge" (Alcock, 1902). He also left short but graphic descriptions of many islands. An account of the deep-sea fishes collected from the Lakshaweep Sea has also been presented by Alcock (1894).

The Cambridge University Expedition under the leadership of Prof J. Stanley Gardiner was the next significant event in the marine research of Lakshadweep, though, the expedition touched only Minicoy at the southern tip of the Archipelago. The results of the marine biological and oceanographic research were reported in the two volumes of *'Fauna and Geography of the Maldive and Laccadive Archipelagoes* (J. S. Gardiner (Ed.) 1903–1906). Later Hornell (1910) and Ayyangar (1922) described briefly the tuna fishing methods in the Lakshadweep. The establishment of the research centre of Central Marine Fisheries Research Institute and the Department of Fisheries in the Lakshadweep in 1958 and 1959 respectively gave a fillip to the fisheries research in this remote area. In the last 28 years scientists of the CMFRI and the National Institute of Oceanography have furthered our knowledge on the environmental characteristics, fishery resources, fishing methods and fishery biology of important tunas and live–bait fishes of the Lakshadweep Sea. Researches on corals and coral reefs have also been strengthened.

The icthyofaunal studies

A valuable contribution towards the knowledge of the icthyofauna of Lakshadweep is that of Balan (1958). He set sail in March, 1954 and after a hazardous journey visited the islands of Agatti, Kavaratti, Amini and Kadmat. He has documented from these islands 80 species of fishes belonging to 65 genera. Jones and Kumaran (1959) while describing the fishing industry of Minicoy also listed 154 species of fishes from the lagoon and reef, many of which being new records. The list was further elaborated by Jones (1960a, 1960b, 1969) and Jones and Kumaran (1967a, 1967b, 1967c) and culminated in the publication of the *'Fishes of the Laccadive Archipelago'* (Jones and Kumaran, 1980). In the book they have documented information on 603 species of reef fishes including many bathypelagic forms. Due consideration has been given to the systematics of commercially important tunas and related fishes as well as the common live-bait fishes. This work remains to be the most comprehensive account on the fish fauna of the Lakshadweep.

Exploratory surveys

As early as 1928 the erstwhile Madras Fisheries Department conducted experimental trawling in the Lakshadweep Sea using the Steam Trawler *Lady Goschen* (Sundara Raj, 1930). Material brought up from the Basses de Pedro Bank included *Lethrinus* spp., *Epinepheles* (reef cod), *Lutjanus* spp., and a variety of invertebrates. Jones (1959a) has given a detailed account of the co-operative oceanographic investigations carried out by R.V. *Kalava* in the Lakshadweep waters. During the cruises of this vessel many valuable information on the oceanographic conditions and fishery resources of the seas around Lakshadweep were collected. The

larval fishes collected from this area included those of *Xiphias gladius, Istiophorus gladius, Katsuwonus pelamis, Euthynus affinis* and *Auxis* sp. (Jones, 1958). The results of the exploratory surveys of R.V. *Varuna* in the sea around the islands have been well documented by Silas (1969, 1972).

Assessment of fishery potential of the Lakshadweep Sea

The steady increase in landings and decrease in mean length of the yellowfin tunas exploited by the Japanese tuna fishing fleet had caused much concern over the tuna populations in this area since 1950s. Therefore, studies on the assessment of stock of tunas in the Lakshadweep and nearby seas were given priority in the research programmes of the CMFRI. The earlier estimates revealed that only a total of 650 tonnes of fish were being fished from the Lakshadweep waters annually against a potential yield of 3,300 t of pelagic and demersal fishes, most of which being tunas (Jones, 1968). George *et al.* (1977) estimated a projected exploitation potential of 50,000 t of tunas against the total local annual exploitation of 2,740 t.

Research on tunas and related fishes, and their fishery

Scientific observations on the craft and gear and fishing methods began under the erstwhile Madras Fisheries Department. Hornell (1910), Ayyangar (1922) and Ellis (1924) recorded their valuable observations on the fishing tackles and tuna fishing industry in the islands. Hornell (1910) gives an account of the 'pole and line' fishing method of Minicoy. Jones and Kumaran (1959) described the fishing craft, the gear and the method as they existed just at the end of the pre-mechanisation era. The mechanised 'skipjack-boat', its fishing gear and fishing methods for skipjack as well as for live-baits are described in Ben Yami (1980) and Silas and Pillai (1982).

Studies on the fishery and biology of commercially important species of tunas and tuna live-bait fishes are being undertaken by the CMFRI at Minicoy since its establishment in this Union Territory. Aspects such as length-frequency distribution, age and rate of growth, length-weight relationship, maturity and spawning and food and feeding habits of the two commercially important tunas viz. the oceanic skipjack and the yellowfin have been studied (Appukuttan *et al.*, 1977; Raju, 1964a, 1964b, 1964c; Thomas, 1964a; Madan Mohan & Koya, 1981). Data on the fishing effort, catch, species composition and catch per unit of effort, relating to the tuna fishery have also been collected.

Investigations on live-bait resources

Realising the importance of live-baits for a successful and sustained tuna fishery, Jones (1960–1980) carried out long-term researches on them. During the cruises of R.V. *Kalava* he observed the occurrence of *Spratelloides delicatulus* around many islands and pointed out its importance as potential live–bait (Jones, 1960a). Subsequently, in 1961 he recorded *S. japonicus*. Later Jones (1964a) published the results of a preliminary survey of the live-bait fishes of the Lakshadweep wherein 45 species have been listed. A detailed account on the fishing method, storage and utilisation of the live-bait fishes has been published (Jones, 1958).

The next major contribution towards our knowledge on the live-baits of Lakshadweep is that of Thomas (1964b) who during 1960–'61 period made some observations on the fluctuations of live-bait fishes in Minicoy. He observed that 11 species of these fishes were being regularly fished. Studies on the length-frequency distribution of *Lepidozygus tapeinosoma, Archamia fucata, Caesio caeruleus, C. tele, C. crysozona, Diplerygonotus leucogrammicus, Chromis caeruleus* and *Spratelloides* sp. were also made (Thomas, 1964b). Jones (1964b) thought of *Tilapia mossambica* as an alternative source for live-baits and sent a consignment of 21 specimens to Minicoy. Today, the species has established throughout the Lakshadweep; in all fresh water wells and ponds, and is found in purely marine conditions also in some of the tidal pools at the southern tip of Minicoy. However, *Tilapia* has not been a successful alternative to the other live-baits.

Pillai and MadanMohan (MS) paid some attention to the ecology and biology of reef fishes at Minicoy with special reference to live-baits during the 1981–'84 period. Based on two years data, the biology of several species was worked out for the first time. These included *Spratelloides japonicus* and *S. delicatulus* (Madan Mohan and Koya, 1986c), *Chromis caeruleus* (Madan Mohan, Pillai and Koya (in press), *Dascyllus aruanus, Acanthurus triostegus* and *Abudefduf glaucus* (Pillai, Madan Mohan and Koya) (MS).

The microhabitat and coral association of the live-bait-fishes of the lagoon of Minicoy was elucidated by Pillai(1983). A correlation between the lunar cycle and the occurrence of pelagic bait fishes was also demonstrated (Madan Mohan) (unpub.). Based on prolonged observations on the corals of Minicoy, Pillai (1983) pointed out the impact of mass mortality of corals on reef associated fishes including live-baits.

Fishery environmental studies

The physical, chemical and biological parameters of the marine environment and also some oceanographic features such as currents, water masses, upwelling etc. have been studied by the CMFRI, in the recent past, during the cruises of R.V. *Kalava* and R.V. *Varuna*.

The investigations of Ramasastry (1959) and Jayaraman *et al.* (1960) have revealed the existence of four distinct water masses in the southern Arabian Sea. Prasad (1951) and Jayaraman *et al.* (1960) have brought to light the influence of the nutrient rich Antarctic bottom water in the Lakshadweep sea area. The physico-chemical characteristics of the water studied by Jayaraman *et al.* (1960) showed that the highly nutrient rich water was maintained around the islands for considerable length of time by the geotrophic pattern of circulation existing around the islands. Later Ramamirtham (1979) showed that a large cyclonic gyre type circulation exists in the northern region while an anticyclonic gyre type circulation exists in the southern region of the islands mainly in the sub-surface layers associating with the convergence and divergence in the sea. Other works of oceanographic importance done in the Lakshadweep seas and adjacent waters are those of Patil and Ramamirtham (1963), Rao and Jayaraman (1966), Sankaranarayanan (1973) and Sen Gupta *et al.* (1979).

Productivity studies

The early studies on the primary production of the tuna grounds of the Lakshadweep is by Prasad and Nair (1964). Later Nair and Pillai (1972) estimated the productivity of the reefs in Minicoy lagoon. Qasim *et al.* (1972) made a fairly comprehensive study on the primary production of the ambient waters and reefs of Kavaratti atoll. The primary production of the sea grass beds of Kavaratti atoll has been determined by Qasim and Bhattathiri (1971). Other major investigations on primary production of Lakshadweep waters are those of Bhattathiri and Devassy (1979) and Qasim *et al.* (1979).

The earliest work on zooplankton of the Lakshadweep is that of Wolfenden (1906) on copepods. Jones (1959) carried out some studies on the zooplankton assemblages around some of the northern Lakshadweep islands. During the cruises of R.V. *Varuna,* Silas (1972) estimated the zooplankton biomass closer to the reefs of the islands. He has also made some studies on the Deep Scattering Layers closer to the islands and suggested that the DSL constituted an important source of forage to pelagic fishes. A quantitative study of the zooplankton of the Kavaratti and Kalpeni atolls has been made by Tranter and Jacob (1972) who accounted for the loss of zooplankton over the reefs. Others who did creditable work on the zooplankton assemblages of the Lakshadweep waters are Prasad and Tampi (1959), Goswamy (1973, 1979, 1983), Madhu Pratap *et al.* (1977), Nair and Rao (1973) and Mathew (M.S.).

Marine invertebrates

Early information on the marine fauna of Lakshadweep are mostly based on the various articles published in the two volumes of *'Fauna and Geography of Maldive and Laccadive Archipelagoes'* (Gardiner(Ed.) 1903–1906). Nagabhushanam (1972) made a detailed ecological survey for the marine fauna of the Minicoy atoll. The marine animals so far studied, mostly from Minicoy, include foraminifera (Chapman, 1895); corals (Gardiner,1903b,1906a,b,c; Cooper, 1906; Pillai, 1971a, 1971b, 1972); sponges (Thomas, 1979); other coelenterates (Borradaile, 1906 d; Browne, 1906a, 1906b), nemertines (Punnet, 1903); echiuroids (Shipley,1903a); sipunculoids (Shipley, 1903b); stomatopods (Lanchester, 1903); crabs (Borradaile, 1903a, 1903b, 1903c, 1903d, 1906a, 1906b, 1906c; Kathirvel (MS); Sankarankutty, 1961); lobsters (Meiyappan and Kathirvel, 1978; Pillai *et al.,* 1984a); alphids (Coutiere, 1903, 1905, 1906); molluscs (Eliot, 1906; Hoyle, 1906; Smith,1906; Hornell, 1910; Rao *et al.,* 1974; Nair and Dharmaraja, 1983; Panicker, (unpub.); Appukuttan and Pillai (MS) and echinoderms (Bell, 1903; Sivadas, 1977; Murty *et al.,* 1980; James (MS).

Though the marine fauna of Lakshadweep is rich and varied the present day information is mostly confined to Minicoy. The living marine resources of the northern Lakshadweep islands need further study. The CMFRI has programmes for indepth surveys of the islands with a view to furthering our knowledge on the marine ecosystem, the fauna and the resources. While the resources may be exploited rationally, measures for conservation of the ecosystem, especially the corals and coral reefs have to be given due importance in future plans for the development of the islands.

ENVIRONMENTAL FEATURES OF THE SEA AROUND LAKSHADWEEP

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Introduction

The sea around Lakshadweep forms a part of the southeastern Arabian Sea, also known as the Lakshadweep Sea. The importance of the waters in this region with their special ecological conditions has been shown by Jones (1959c). The submarine Laccadive–Chagos ridge located in this region greatly influences the water masses and Cooper (1957) suggested the importance of the ridge in the enrichment of the upper waters of the mid-ocean in the Arabian Sea. The region also supports a rich pelagic fishery. A knowledge of the environmental conditions of the waters around Lakshadweep, would help in understanding several problems of oceanographic and fishery nature. The Central Marine Fisheries Research Institute was the first to initiate detailed oceanographic investigations on the environmental features in this region as early as 1959 (Jayaraman *et al.,* 1959, 1960) and since then a lot of information have been added by the same and others. The following is an account of the present day information available on the environmental characteristics of the waters around Lakshadweep.

Wind system

For a better understanding of the environmental characteristics of the Lakshadweep Sea, a knowledge of the general wind systems and currents prevailing in the northern Indian Ocean and Arabian Sea in particular is essential.

The Arabian Sea and Bay of Bengal which form parts of the northern Indian Ocean are subject to seasonal monsoon winds. During the summer the southwest monsoon and during the winter, the northeast monsoon prevail over this region. In summer, a seasonal low pressure area develops over the Central Asia which causes the winds to blow persistently from southwest forming the southwest monsoon winds. In winter, a high pressure zone develops over the Tibetan plateau and its neighbourhood. The winds from this high pressure region move towards the low pressure belt in the Equatorial Indian Ocean, blowing from northeast to southwest which form the northeast monsoon. The winds are southwesterly during southwest monsoon and northeasterly during northeast monsoon. During March–April and October–November the winds are weak and variable. The atmospheric circulation undergoes a complete reversal in direction during a year. In general, the winds are stronger and steadier during the southwest monsoon than during the northeast monsoon. In the Arabian sea, the southwest monsoon prevails during June–September and northeast monsoon during November – February, the transition being during October.

Sea surface circulation

The sea surface circulation in the Arabian sea, in general, follows the prevailing wind system over the area with stronger and steadier currents during the southwest monsoon compared to those in the northeast monsoon. During the southwest monsoon the surface currents in the open ocean are eastwards and clockwise in direction due to the coastal configuration. It flows northeastwards along the Arabian coast and southwards along the Indian coast as wind driven ocean current. This clockwise circulation strengthens with the progress of southwest monsoon. This coastal current is a continuation of the Somali Current flowing along the East African coast. During the N.E. monsoon the general surface circulation is more or less reversed in the open ocean and is northwestward with a counter-clockwise circulation along the coasts. Along the west coast of India the surface flow is mostly in the north-northwest direction upto 20°N changing to west-northwest direction thereafter, and off the Arabian coast it moves in the southwest direction. As stated earlier these directions of flow are direct effects of the monsoons and the clockwise or the counter clockwise patterns are set up during the transition periods when the winds are variable. The counter clockwise circulation ceases by the end of January and the clockwise coastal current is gradually established by May. This reversal of the coastal current system along the coasts in the Arabian sea is not simultaneous all over the area. During February–April the predominant flow in the open sea is towards west or northwest.

Hydrographic conditions

The oceanographic conditions in the sea around Lakshadweep reveal many interesting environmental features. During summer (Jayaraman *et al.* (1959), which is the period of the year when stable conditions exist in the environment in the Arabian sea, the distribution of temperature indicates the presence of a more or less isothermal layer down to 50 m. The temperature discontinuity layer (also known as the thermocline layer) is found to be between 75 and 150 m. The salinity maximum is observed to occur within a tongue of high saline water at about 100 metres. At deeper depths comparatively low saline waters are found indicating the presence of sub-antarctic drift.

The dissolved oxygen content from surface layers down to 50 m is more or less uniform in the region. From 75 m downward there is a rapid decrease in oxygen content and at 150 metres the oxygen concentration of the waters attains very low minimum values. This layer of sharp sudden decrease in oxygen content corresponds to the layer of the thermocline. This oxygen poor layer continues further below and extends down from 150–500 m. The density (sigma-t) values range between 25.00 and 27.00 within this layer. At deeper depths from 700–1000 m, the values increase and at 1000 m it is nearly double that of the minimum seen above. The oxygen minimum layer is several metres thick and the upper level of this is present at 150 metres as compared to about 300 m in the other open parts of the ocean. These features conclusively point to a rather high level of productivity of the Lakshadweep waters. Below 1000 m there is a remarkable increase in oxygen values up to 3.5 ml/l compared to 0.5 ml/l in the oxygen-deficit layer found above. This has been attributed to the south polar water sinking at the Antarctic and sub-tropical convergences and spreading in the deep bottom into the basins of the Indian ocean.

Water masses: Three main types of water masses are noticed during the summer in this region (Jayaraman *et al*, 1960). They are:

1) The water mass characterised by rather sharp salinity gradients of very small temperature range and density (sigma-t) values between 21.00 and 23.00 from surface down to 75–100 m, corresponding to the Arabian Sea upper sub-surface waters described by Sastry (1960) as the water mass which participates mostly in the upwelling and sinking phenomena.

2) The Arabian Sea lower sub-surface water mass characterised by a steep temperature gradient with a salinity range hardly exceeding 0.8‰, sigma-t values between 23.00 and 25.00 and much better defined than the first one.

3) The Indian Ocean equatorial water mass below 200 m having small temperature and salinity gradients and appearing like isohaline waters at certain places.

Water movements: The existence of circulatory water movements (eddies) around the islands at practically all levels down to 500 m has been observed from the nature of the density surfaces and geopotential anomalies. Anticyclonic movements (eddies) are present in the upper 100 m and reverse of that below that level. These eddy-like circulatory motion of the waters helps to keep the fish eggs and larvae within the highly productive waters in the vicinity of the islands for a considerable length of time.

It would be worth mentioning here that these circulatory water movements considered typical of island regions are responsible for high levels of productivity observed in the Lakshadweep Sea (Sen Gupta *et al.*, 1979). They have also found that patterns of distribution of nutrients and the nutrients-oxygen relationships were similar to those observed in the other parts of the Arabian Sea. The general upsloping of the water masses around the islands is attributed to the vertical turbulent mixing and wind induced upwelling in the area.

These circulatory water movements are present during winter also, but with lesser intensity and particularly limited to a shallow depth of about 200 m (Patil, *et al.*, 1963). Significant circulatory movements are found in the northern region especially near Bitra Island where it is cyclonic while near Agatti and southeast of Kiltan islands it is anticyclonic. Superimposed upon this general circulatory movements around the islands, the northwesterly drift produced by the prevailing winds is noted in the upper 30 m towards west of Suhelipar, and further towards east due south of Agatti Island. North of Agatti and Androth islands an easterly drift in the upper layers was noticed. An important characteristic of the season is the sinking which was observed in the western region of Bitra-Agatti-Suhelipar along the 23.00 sigma-t surface. High surface salinities were also observed during winter especially in the north-northwestern region, that is the region of the Bitra-Chetlat-Kiltan region, compared to the summer season. This is supposed to be due to the excess of evaporation over precipitation which is characteristic of the winter season. The water masses viz., Arabian sea lower sub surface

water and the Indian Ocean Equatorial Water contribute mainly upto 2000 m depth and the presence of Antarctic Intermediate water especially in the eastern part of the Lakshadweep region below 2000 m depth was traced.

Chemical Characteristics of waters: The chemical characteristics of the waters of the lagoon and the sea around Kavaratti atoll such as salinity, pH, total alkalinity, dissolved oxygen, reactive phosphate, total phosphorus, chlorophyll and the particulate organic carbon showed high degree of variability except pH and alkalinity, with location in the lagoon. (Sankaranarayanan, 1973). A marked diurnal variation in the oxygen concentration of the waters of the lagoon was found whereas other chemical factors, mentioned above, did not show significant changes. It was also observed that most of the phosphorus present in the waters was bound organically. Sediment phosphorus showed very low values (0.04–0.06% as P_2O_5) indicating the poor retention of phosphorus with the sediments. It was noted that the benthic macrophytes play a role in the recycling of nutrients in the lagoon (Sankaranarayanan, 1973).

Sea surface temperatures: The sea surface temperatures in the open Arabian Sea were found high during May–June period while a lowering of temperature was observed in the month of July with the advance of the southwest monsoon. The lowered sea surface temperatures ranged from 1°C to as much as 4.5°C (Rao *et al.,* 1976).

Oxygen maxima and minima: The depths of occurrence of oxygen maxima (4.5–5 ml/l and above) during the summer, southwest monsoon, post-monsoon and northeast monsoon have been found to be in the upper surface layers up to 40m, 10m, 10m and 10m respectively whereas those of oxygen minima (0-1.0ml/l) during the same periods were at 300m, 150m, 100m and 300m respectively in this region (Rao *et al.,* 1970). These depths of occurrence of oxygen maxima and minima appear to be governed mainly by water movements, circulation and mixing, in addition to the biological processes.

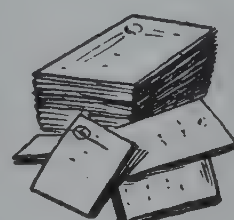
Water characteristics around Minicoy Island: From the distribution of temperature, salinity, dissolved oxygen and density, it has been found that upwelling occurs in the very close vicinity of the Minicoy Island during the November – December period (Rao *et al.*, 1966). This phenomenon was found limited to the upper 150m. The presence of diverging current systems has been attributed to the causes of upwelling. During this period the general pattern of the current in the southern part of the Arabian Sea is westerly. Due to the coastal configuration, a north-northwesterly current develops off the west coast of India. These two currents diverge in the vicinity of Minicoy leading to upwelling in this region. The relatively low saline lighter water seen in the surface layers in the nearby regions can be the Bay of Bengal water possibly carried westward by the North Equatorial Current (Rao *et al.,* 1966). It would be worth mentioning here that this upwelling is also presumed to be due to seasonal variations in wind-induced upwelling (Sen Gupta *et al.,* 1979).

Convergence and divergence zones: From dynamical studies of the Indian Ocean Expedition data during winter one large divergence zone around 71°E and 9°30′N has been inferred and a convergence zone with an axis roughly along 74°E around 8°N has also been found. The distribution of oxygen at 75m depth further confirmed the area and extent of the divergence zone during the winter. A region of convergence has also been observed around 8°N and 71°30′E in the upper 200 m during the southwest monsoon period The divergence zone corresponds to the region of upwelling and the convergence relates to sinking. The divergence zone or upwelling area mentioned above is thus in region west of Minicoy and the sinking or convergence zone in the region east of Minicoy in the open ocean during winter. During the summer the sinking or convergence of waters is found in the region west of Minicoy in the open ocean. Boisvert (1966) has observed that in December the surface water mass (up to 100 m) originates in the Bay of Bengal and flows southward along the east coast of India, rounds off Sri Lanka and moves northward along the west coast of India and also enters the Lakshadweep region.

Environmental features in relation to fishery: The information on the environmental characteristics of the sea around Lakshadweep given above are very interesting and useful from the point of view of the local fishery. It is seen that the sea around these islands are highly productive. The circulatory movements (eddies), the vertical turbulent mixing and wind induced upwelling in the region are contributory to this high productivity. The coral island of Minicoy (8°07′N, 73°18′E) is a major tuna fishing centre in the Indian Ocean (Jones and Kumaran, 1959) and the importance of this region from the point of tuna fishery has been well recognised. The presence of divergence and convergence zones in the open ocean near to Minicoy, the presence of upwelling in the close vicinity of the Minicoy Island, the eddy systems present there, and the presence of the relatively low saline waters

seen in the surface layers during the November–December period contribute to the high productivity of the area. It has been shown that a stable eddy system present close to Barbados Island causes the littoral animals with long pelagic larval stage to be more abundant than in the exposed areas. Similar eddies are present downstream near the Lakshadweep islands, and it may be worthwhile to investigate whether this feature has any bearing on the tuna fishery. The existence of the anticyclonic eddies around these islands in the upper 100 m support a high productivity. The abundance of decapod larvae, including the red prawns observed in this area in plankton hauls is probably a result of these eddies. (Sen Gupta *et al., 1979*). According to Jones and Kumaran (1959) in the Minicoy area, the tuna fishery is operative from September–April, the peak season being December–March. It is possible that the features mentioned above were observed during late November–December and these may have a considerable impact on the peak tuna catches of this region.

The importance of the sea around Lakshadweep from the point of tuna fishery is well known. The information on the environmental conditions of the waters here are insufficient for a better understanding and exploitation of the fishery. This is particularly noteworthy, since in many areas, in the world, tuna investigations have always been supported by large scale oceanographic studies. It may be mentioned here that one of the most important discoveries in oceanography, namely the Chromwell Current is also associated with systematic investigations for tunas in the Central and Equatorial Pacific by the Pacific Oceanic Fishery Investigations (POFI) group. It is, therefore, necessary, to follow the exact sequence of events for the ultimate correlation between the environmental processes and the tuna fishery of Lakshadweep. This requires more detailed knowledge on the environmental features and the fishery during different seasons of the year for deriving a better correlation.



PRODUCTIVITY OF THE SEAS AROUND LAKSHADWEEP

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The seas around the Lakshadweep and the reef lagoons are of great ecological significance as they influence the fauna and flora associated with the coral reefs and the high sea resources to a great extent. The waters have been found to be highly productive at the primary and secondary levels.

The euphotic zone of the Lakshadweep Sea is almost over 90 m. Hence though the production per unit volume in the surface waters may not be of higher order, the integrated values are high. The unit volume prodution varies from 8 to 34 mgC/m^3/ day with the maximum rates at Minicoy where the skipjack tunas are abundant. The integrated value for the whole water column is of the range of about 300 mgC/m^2/day which is rather high for oceanic waters. The observations made by the scientists of the Central Marine Fisheries Research Institute have also revealed the existence of an oxygen minimum layer of several metres thickness with the upper layer at 150 m which is closely related to the high organic productivity. Besides, it has also been observed that the geostrophic circulation prevailing in this area helps to maintain the highly productive waters around the islands for considerable length of time. The influx of Antarctic bottom water has its influence on the organic productivity (Jayaraman *et al.,* 1960).

Satellite imageries from Landsat and Indian Remote Sensing Satellite and ocean colour sensing from Coastal Zone Colour Scanner (CZCS) of NIMBUS–7 can provide the general level of productivity as well as water masses in the area of Lakshadweep (Silas *et al.,* 1985).

Therefore remote sensing of this region will open up new frontiers in the marine fisheries and help in the proper exploitation and management of tuna and other oceanic resources.

The waters have been found to be highly productive at the secondary level too. The zooplankton washed across the reef from the sea into the lagoons provides a rich source of food for the reef building animals as well as for the communities associated with the reefs. In spite of the importance of the zooplankters in the reef ecology these organisms in the Lakshadweep marine environment have received very little attention. What little information available are due to the works of Gardiner (Ed.) (1906), Silas (1972), Tranter and George (1972), Goswami (1973), Nair and Rao (1973), Madhu Pratap (1977) and Mathew (MS).

Eversince the classical work of Wolfenden (1906) on the copepods of the Lakshadweep and Maldives the zooplankton of the Lakshadweep Sea has received no attention until the work of Silas (1972) on the standing crop of zooplankton and on the Deep Scattering Layer. According to him the estimated monthly mean standing crop of zooplankton varied between 26 and 144 ml per 1000 m^3 of water in the sea around Lakshadweep.

Silas (1972) conducted surveys on bioscattering in the shallower depths off Minicoy, Agatti, Pitti, Kavaratti Kalpeni and Androth islands and off Suhelipar. The surveys indicated definite concentrations of, zooplankton and micronekton in the DSL which evince characteristic vertical migration.

The samples collected by Silas (1972) from the DSL from the vicinity of the islands contained zooplankton groups in the numerical proportion of, copepods (65.1%), ostracods (11%), chaetognaths (8.9%), appendicularians (5.5%), euphausiids and decapods (2.5%) and siphonophores (1.6%).

When considered volumetrically it was the euphausiids, the staple food of the tunas and bill-fishes that dominated over all the other zooplankters. The euphausiid fauna is especially rich in the sea around Lakshadweep. These purely oceanic organisms which form an important constituent in the DSL occur in large quantities even very close to the islands owing to the absence of any freshwater outlets or brackishwaters (Mathew, MS).

Among the euphausiids the most abundant species found were *Thysanopoda monacantha, T. tricuspidata, Euphausia diomedeae, E. sibogae, Nematoscelis gracilis, Stylocheiron armatum* and *S. affine*. Of these the first named two species are relatively larger, growing to about 30 mm in length. On one occasion, 1830 specimens of *T. monacantha* per hour of trawling were caught from the DSL observed near Suhelipar. The other species of euphausiids that occurred in appreciable quantities in the epi-and meso-pelagic zones of the seas around Lakshadweep islands are *T. astylata, T. orientalis, E. pseudogibba, E. tenera, Pseudeuphausia latifrons, N. tenella, Nematobrachion flexipes, S. longicorne, S. suhmi, S. microphthalma, S. abbreviatum* and *S. maximum*. However, there has been no record of catching any of these species from the coral lagoons and atolls.

Pursuing the problems of coral reef nutrition Tranter and George (1972) studied the zooplankton abundance at Kavaratti and Kalpeni atolls during the October–December period in 1968. They observed higher biomass values at surface by night when dense swarms of ostracods swarmed at a rate of 1000 individuals per 1 m^3 of water. The biomass was greatest seaward of the western lagoon of Kavaratti. The biomass, they found, to be depleted enroute from ocean to lagoon. The coral reef commonly nourish from the oceanic plankton.

In April 1971, Goswamy (1973) made studies on the zooplankton of the lagoons and seas of the Lakshadweep. Contrary to the finding by Tranter and George (1972) he obtained high biomass of zooplankton in the lagoon than in the open sea. He got upto 178 ml of zooplankton per 1000 m^3 of water from the lagoon and in the sea it was 58 ml per 1000 m^3 of water. The major groups of zooplankton encountered during the studies were: copepods (52 sp.), chaetognaths (8 sp.), mysids (3 sp.), polychaetes (5 sp.), amphipods (2 sp.), decapods, and fish eggs and larvae. Certain harpacticoid copepods, gammarid amphipods and mysids were found to be endemic to the lagoons.

A specialised study on chaetognaths of the Kavaratti and Kalpeni atolls and of the adjoining sea was carried out during the October–December period of 1968 by Nair and Rao (1973). Thirteen species belonging to four genera namely *Sagitta, Krohnita, Pterosagitta* and *Spadella* were found to be present. In the Kavaratti lagoon an average catch of 1,540 chaetognaths per 1000 m^3 of water were obtained while the number was 31,210 per 1000 m^3 of water from the seaside. At Kalpeni the numbers were 10,680 and 31,750 per 1000 m^3 of water for the lagoon and sea respectively. Thus as far as the chaetognaths were concerned the biomass

was always high on the sea side. The reason for this has been attributed following Tranter and George (1972) to the feeding intensity of the coral polyps and the coral dwelling animal communities.

Madhu Pratap *et al.* (1977) have studied the composition and abundance of various groups and species of zooplankton at Kavaratti, Agatti and Suhelipar atolls and in the seas around Kavaratti and Agatti. They found that higher biomass and diversity occurred in the sea surrounding atolls than in the lagoons. A maximum of 6.2 ml per 10 mts surface haul with a square net of 0.0625 m^2 mouth area was obtained from the sea. While the plankton in the sea averaged to 3.5 ml, in the lagoon it was 1.6 ml per 10 mts haul. This confirmed the finding of Tranter and George (1972) that zooplankton was lost in transit across the reef into the lagoon and is probably utilised by the reef communities.

Madhu Pratap *et al.* (1977) found that among zooplankton the copepods dominated over the others except in Kavaratti lagoon where the planktonic molluscs were abundant forms. Their samples included eight species of siphonophores, five species of chaetognaths, zoea of crab, pagurid, sergestid and caridean larvae, mysids, gastropods, lamellibranchs, pteropods, polychaetes, appendicularians, amphipods, ostracods, salps, doliolids etc. The studies suggested the role of zooplankton in the nutrition of the coral reef community.

The studies so far made have revealed that the coral lagoons and the seas of the Lakshadweep islands are comparatively rich in their zooplankton assemblages. According to Silas (1972) several factors are responsible for the enrichment and subsequent abundance of zooplankton they being, terrigenous products that diffuse or carried by the currents from the islands, the presence of islands in the boundary zones of major oceanographic features, perturbations produced by the islands in adjacent waters and the accumulation of inorganic nutrients by the benthic algae from the passing water. Further studies on the quantitative distribution, seasonal variation and the role of environmental parameters on the occurrence and abundance of zooplankton in general and of various groups in particular are to be made in the lagoons and seas of the Lakshadweep to augment our present knowledge.

EXPLOITED AND POTENTIAL RESOURCES OF TUNAS OF LAKSHADWEEP

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Introduction

Oceanic species of tunas such as skipjack *(Katsuwonus pelamis)* and yellowfin tuna (*Thunnus albacares*) constitute the major tuna resources taken from the Lakshadweep waters from September–October to May every year. They are being exploited from these islands by pole and line fishery with live-baits (Silas and Pillai, 1982). At Minicoy, an organised fishery for tunas is in vogue for a number of years, and from 1960 onwards pole and line fishing has been adopted in the other islands of Amini group with the introduction of mechanised boats. In seventies, the traditional tuna fishing boat ('odums') were replaced by mechanised boats fitted with live-bait tanks. Thus tuna fishing which plays a major role in the economy of the Lakshadweep became popular.

The total tuna catch in the Lakshadweep Is. and the all India total tuna landings during the period 1970–'84 is presented in Fig. 1. It is evident that the total catch has increased considerably from 571 tonnes in 1970 to 4,101 tonnes in 1984. Island-wise tuna catch data and the number of mechanised boats (25′ and 30′)

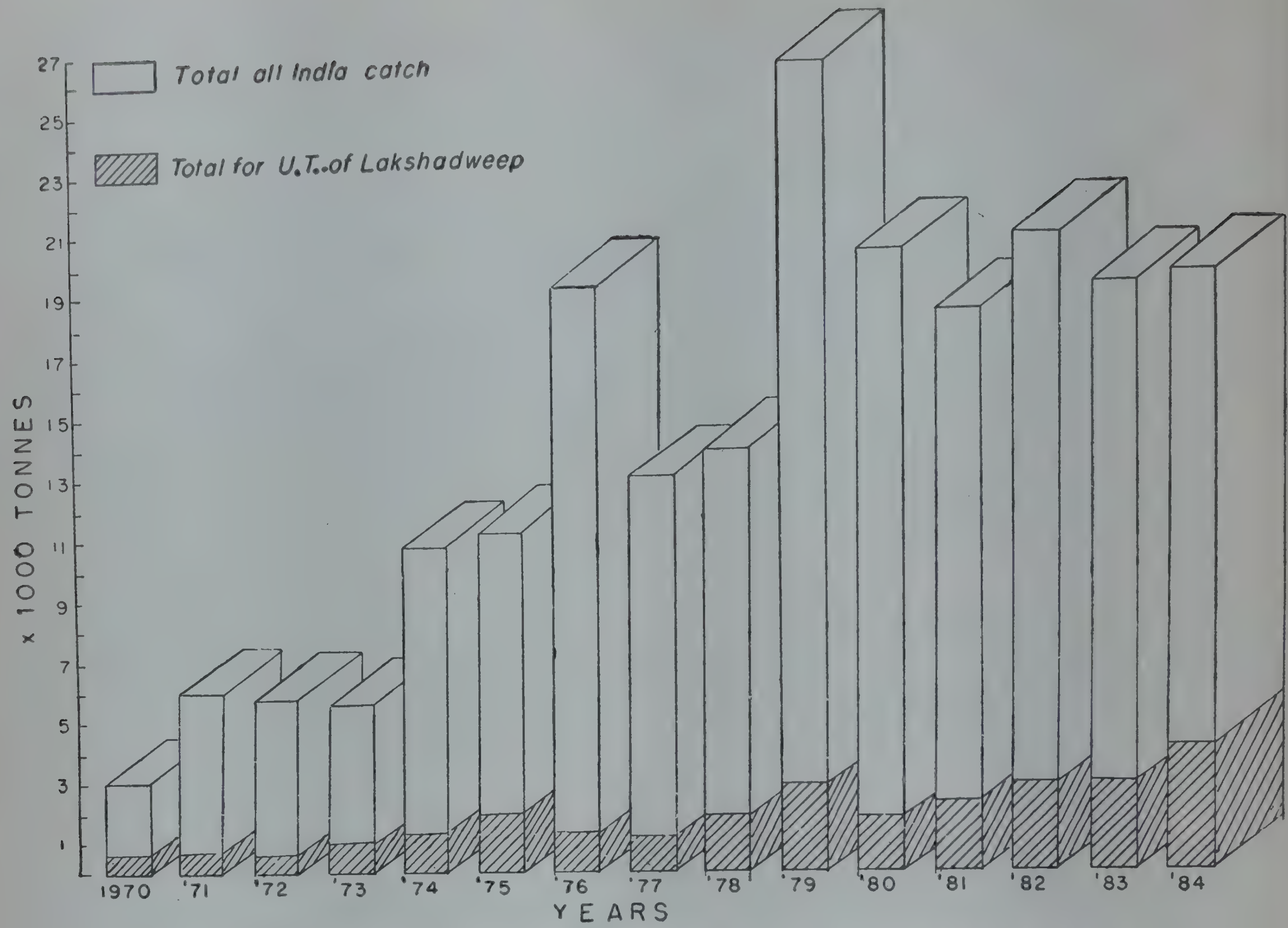

Fig. 1. Total tuna catch in the Lakshadweep and the total all India tuna landings for the years 1970-'84.

available during the period 1978–'83, are presented in Table 1. Increase in the number of mechanised boats in the tuna fishery is evident from 1978 and concomitantly catch has also increased to a considerable extend.

Detailed information on the catch, effort, species composition, biology and population dynamics of tunas are available from the Minicoy Island and hence the information presented here are based on the data collected by CMFRI from this area.

The pole and line fishery for tunas at Minicoy Island has earlier been reported by Hornell (1910), Ellis (1924), Mathew and Ramachandran (1956), Jones (1958, 1960a, 1960b, 1964a, 1964b), Jones and Kumaran (1959), Thomas (1954), Varghese (1971), Puthran & Pillai (1972), Ben-Yami (1980), Silas and Pillai (1982) and Madan Mohan *et al.* (1985). There has been a changing pattern in the pole and line fishery in this island through these years. The traditional tuna boat of Minicoy (*'Mas-odi'*) is now replaced by small mechanised boats equipped with live-bait tanks which has resulted in the improvement of the catches. This increase in catch has not created any problem for disposal due to the demand for the traditionally cured fish *'Mas min'* and also due to tuna canning factory at Minicoy.

Craft and gear

The details of pole and line boat, pole and line gear, the bait fish net and bait fish basket are described by Silas and Pillai (1982).

Operation

Fishermen start from their base by 0600 hrs for live-bait fishing in the lagoon. The number of crew range from 10 to 15. The area of the lagoon from where live-baits have to be fished and the mesh size of the bait-fish

Table 1. *Island-wise and year-wise production (in tonnes) of tuna in Lakshadweep*

Year	Name of the Island											Annual total tuna landing (mt)
	Agatti	Amini	Androth	Bitra	Chetlat	Kadmat	Kalpeni	Kava-ratti	Kiltan	Minicoy	Suheli	
1978	899	64	173	92	36	49	21	211	19	311	—	1875
1979	1314	72	303	118	116	100	62	207	86	415	—	2793
1980	490	46	179	104	33	43	27	150	54	643	—	1759
1981	820	81	196	126	38	37	41	395	24	485	—	2236
1982	550	77	243	345	148	38	63	150	102	427	823	2966
1983	731	53	283	166	96	36	59	164	55	273	1121	3037
Annual Average	801	66	230	159	78	50	45	213	57	426	972	3097
No. of Mechanised fishing boats (25' and 30')												
1978	29	14	16	6	9	12	7	16	9	27	—	145
1979	31	17	21	8	12	14	11	21	12	29	—	177
1980	35	18	24	9	13	14	12	25	13	30	—	194
1981	35	18	24	9	13	14	12	25	13	31	—	223
1982	40	22	29	10	15	14	13	30	16	31	—	223
1983	49	29	33	10	17	16	14	37	22	36	—	263

net to be operated depend on the species of live bait available at that time. Normally by about 0900 hrs sufficient quantity of live bait will be collected. Then they go out of the lagoon scouting for tuna shoals. Once a shoal is sighted it is approached, chummed and fished. If the live-bait fishing, scouting and chumming are quick, they return to the shore by noon with good catch. Then they unload the catch and again go for bait fishing for a second trip. On the other hand, if the fishing is not successful scouting for tuna shoals may continue till dusk and they return to the shore. The remaining live-bait fish will be stored in the bait baskets floated in the lagoon.

Production

The catch of tunas, standard effort and catch per standard effort during 1976–'85 are given in Table 2.

The catch per standard effort was high during the period 1970–'80, and during the subsequent years it fluctuated between 242 to 334 kg. From Table 2 it is evident that the effort has also increased from 1,060 to 2,422, but the C/SE has not indicated any increasing trend.

Table 2. *Catch, SE and catch per standard effort of tunas at Minicoy* 1976 *to* 1984–'85

Year	Catch (tonnes)	SE	C/SE (kg)
1976	312	1603	194
1977	355	1060	335
1978	539	1317	409
1979	509	1145	445
1980	687	1338	514
1981	327	1176	278
1981–'82	321	1241	258
1982–'83	371	1112	334
1983–'84	343	1370	250
1984–'85	569	2422	235

Biology

Species composition of tuna

Data on pole and line catches indicate that skipjack tuna, *Katsuwonus pelamis* contributed bulk of the tuna catches, while in the troll line catches, always yellowfin tuna, *Thunnus albacares* dominated. During 1980–'81 season *K. pelamis* contributed 78.4% of total tuna catch

followed by 21.31% of yellowfin tuna and stray catches of *Auxis rochei* and *Euthynus affinis* (0.25%). During 1982-'83 season skipjack tuna formed 91.4% followed by yellowfin tuna (8.54%) and *A. rochei* and *E. affinis* (0.06%). In 1983-'84 season skipjack dominated the catch by contributing 84.9% followed by yellowfin tuna (15.0%) and *E. affinis* and *A. rochei* (0.1%). During 1984-'85 season the most abundant tuna was skipjack (93.7%) followed by yellowfin tuna (6.2%), *A. rochei* and *E. affinis* (0.1%).

Size composition of tunas

Studies on the size composition showed that during 1981-'82 season, fork length of the skipjack tuna ranged from 270-669 mm with size group 470 mm to 530 mm dominating in the pole and line catch. For yellowfin tuna the length of fish ranged from 300 - 1,380 mm while the size group 460 - 540 mm dominated the catch. During 1982-'83 season the length of *K. pelamis* ranged from 280 - 680 mm while the size group 460 - 570 mm dominated in the catches. For *T. albacares* the length ranged from 250 - 1,120 mm and the size group 400 - 550 mm were predominant in the catches. During 1983-'84 season the length of *K. pelamis* ranged from 242 - 680 mm while the size group 460-580 mm dominated. For *T. albacares* the length ranged from 230 - 1,150 mm while the size group 500-600 mm dominated. During 1984-'85 season the skipjack tuna were taken over a wide range of size from 300-720 mm and the dominant group was at 530-630 mm. For yellowfin tuna the size ranged from 310-1,009 mm and bulk of the catches consisted of fish in the length range of 560-600 mm.

Length-weight relationship of K. pelamis *and* T. albacares

440 specimens of skipjack and 134 specimens of yellowfin tunas were collected from Minicoy fish landing centre and data obtained were analysed. Regression equations for both the species were calculated for males and females separately. Testing for significance difference between regression equations of both the sexes were performed for both species. In both species regression lines for males and females were found coincidental. Therefore data for males and females were pooled together for both species and common regression equations were derived.

For skipjack tuna

$$\text{Log } W = -5.80855 + 3.39301 \text{ Log } L$$

For yellowfin tuna

$$\text{Log } W = -11.036032 + 3.001012 \text{ Log } L$$

Age and growth studies of K. pelamis *and* T. albacares

For skipjack tuna, based on the monthly length-frequency analysis and monthly progression of modes, lengths of 1, 2 and 3 years old skipjack were estimated as 360 mm, 564 mm and 682 mm respectively. By applying Von Bertalanffy's Growth Equation for the one year old skipjack the size observed was 367 mm, for two years old 573 mm, for three years old 690 mm and for four years old 777 mm. The monthly growth rates for four years were as 30.58 mm, 17.16 mm, 9.75 mm and 7.25 mm respectively.

Based on monthly length-frequency analysis the progression of modes length of one and two years old yellowfin were estimated as 500 mm and 780 mm. By applying Von Bertalanffy's Growth Equation, length upto seven years was 506, 769, 952, 1,088, 1,187, 1,259 and 1,311 mm respectively with monthly growth rate for seven years as 42.16 mm, 21.91 mm, 15.25 mm, 11.33 mm, 8.25 mm, 6.00 mm and 4.53 mm respectively.

Spawning biology

One of the important technical approaches to investigate the resource characteristics of oceanic skipjack tuna, *Katsuwonus pelamis* which forms 70 to 90% of the tuna catches of Minicoy, was to study the phases of its life history. The main aspects covered were maturity, sex ratio, spawning season and frequency of spawning and fecundity.

Maturity: For this study data collected during the calendar year 1981 and 1982 were analysed. Data revealed that fishes of all seven stages of maturity were available in the catches at Minicoy. Development of ova to maturity was traced for all the seven stages. The frequency distribution of ova diameter measurements from ripe and spawning ovaries of skipjack revealed that this species spawned more than once in a year at Minicoy.

Sex ratio: Ratio of males to females was found as 1:1.18 for the year 1981 and 1:0.98 for the year 1982. For both the years together, females dominated over males but not very significantly. Monthly variations in sex ratio was observed during both the years.

Spawning: Data on the maturity of skipjack over two successive years were analysed which revealed that fishes of various maturity stages were present in any month of the year. When female fishes were divided into three major categories i.e. immature, maturing and

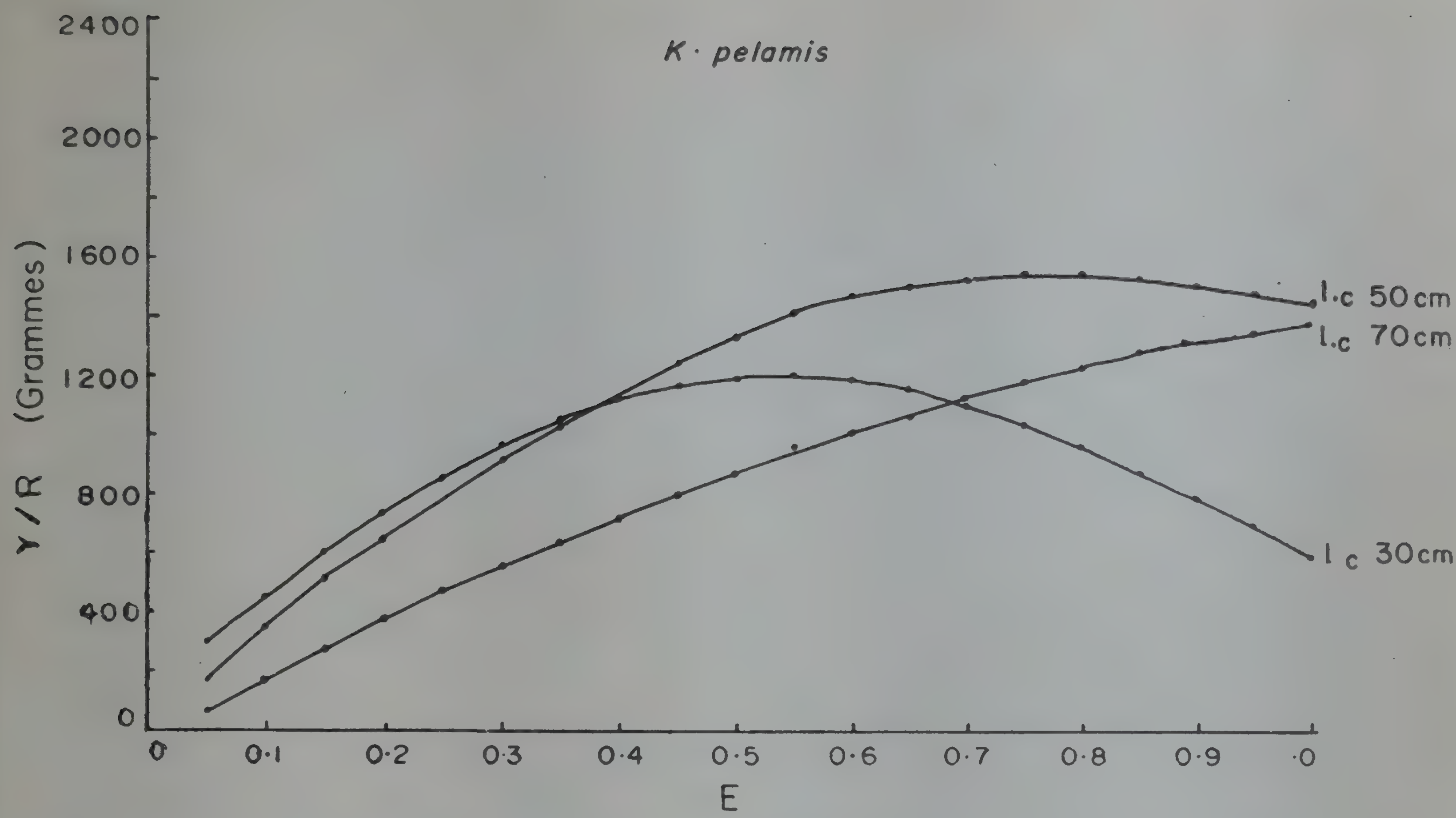

Fig. 2. Yield per recruit of *Katsuwonus pelamis*

as mature, it was seen that mature fish occurred almost throughout the pole and line fishing period. During 1981 peak occurrence of mature fish was from January to May but in 1982 mature fish dominated during all the months except October.

Therefore the occurrence of mature females throughout the pole and line fishing season and the presence of young fishes of about 30 cm during this period, clearly indicates that the skipjack tuna spawns throughout the year in the Minicoy waters.

Fecundity: A total of 23 mature ovaries were examined. Number of mature ova in an ovary ranged from 170,555 to 682,899 when length of the fish ranged from 465 mm to 660 mm. Each fish can produce about one lakh mature ova per kilogram of its body weight. Fecundity of the fish increased with the length and weight of the fish.

Population dynamics of tunas

The values of the different parameters of Von Bertalanffy's Growth Equation for skipjack and yellowfin tunas calculated for age and growth estimations based on the data collected during 1981 and 1982 were used to estimate mortality rates, yield per recruit and present rate of exploitation of both species. For skipjack tuna yield per recruit and present rate of exploitation were calculated as below.

Yield per recruit

Katsuwonus pelamis

The values of different parameters were as below:

W	= 16,372 g	M	= 0.75
lc	= 54 cm	M/K	= 1.54
lr	= 30 cm	$e^{M\,(tr-to)}$	= 1.861

For skipjack tuna, calculating Z (Annual mortality rate) as 2.555 and other parameters as given above, the present exploitation ratio calculated was 0.71 based on the equation

$$F/Z = \frac{Z - M}{Z} = \frac{2.555 - 0.75}{2.555}$$

This indicates that the present level of exploitation of skipjack tuna at Minicoy Island is not affecting this species' stock and the capture of this species in the area has not reached the maximum sustainable yield.

E	Y/R	Ep
0.05	179.1	
0.10	349.4	
0.15	510.6	**0.71**
0.20	662.1	
0.25	803.8	
0.30	934.9	
0.35	1055.3	
0.40	1164.4	
0.45	1261.8	
0.50	1347.1	
0.55	1419.9	
0.60	1480.0	
0.65	1526.9	
0.70	1560.6	
0.75	1581.0	
0.80	1588.2	
0.85	1582.6	
0.90	1565.0	
0.95	1536.0	
1.00	1498.5	

Y/R=Yield per recruit, Ep=Present exploitation rate.

E	Y/R	Ep
0.05	485.9	
0.10	927.2	
0.15	1323.0	
0.20	1671.9	**0.86**
0.25	1972.7	
0.30	2224.0	
0.35	2425.9	
0.40	2577.3	
0.45	2678.2	
0.50	2728.7	
0.55	2729.7	
0.60	2683.2	
0.65	2590.7	
0.70	2456.6	
0.75	2285.9	
0.80	2085.0	
0.85	1863.3	
0.90	1631.3	
0.95	1401.7	
1.00	1188.9	

Y/R=Yield per recruit, Ep=Present exploitation rate.

Yield per recruit

Thunnus albacares

The values of different parameters were as below:

W_∞	= 49,478 g	M	= 0.49
lc	= 45 cm	M/K	= 1.54
lr	= 30 cm	$e^{M\,(tr - to)}$	= 1.426

Adults of yellowfin tuna are highly migratory and deep dwelling and hence only young ones of about one year age are caught at Minicoy by the pole and line fishing. By calculating Z (Annual mortality rate) as 3.488 and other parameters as above the present exploitation ratio for yellowfin tuna was estimated as 0.86. Expanding the fishing operations to areas beyond the present zone of exploitation would widen the scope for realising higher yields.

Observations on the tuna shoals associated with flotsam in the offshore waters off Minicoy

Types of flotsam objects observed: On most of the occasions flotsam objects were wooden material drifting with sea currents towards Minicoy. Other objects found floating along with tuna shoals were nylon nets, rubber pieces, nylon ropes and plastic pieces.

Most of the flotsam had some attached algal material and very rarely a few ascidians. Though very few small fishes were found around flotsams, they disappeared from the sight when tuna fishing commenced around flotsam.

Live-bait fishes used: *Chromis* spp. were the main species used as live-bait followed by *Spratelloides delicatulus*. These were used to chum tunas from floating objects to tuna fishing boats. Out of the 75 fishing boats observed during these studies the quantity of live-bait used by only 28 boats could be recorded which was 57.5 kg.

Always more than one fishing boat approach a floating object. The first boat use livet-bait to chum tuna and on most of the occasions it is not necessary for other boats to throw bait since tuna shoals would be already feeding on live-bait thrown by the first boat.

Tuna catches: Totally 26 number of flotsams were observed from September, 1982 to May, 1983. 75 tuna fishing boats approached these shoals and caught 40,886 kg of fishes around them. The maximum catch was recorded from six floatsams during October when 14 fishing boats could catch 13,371.6 kg of fishes.

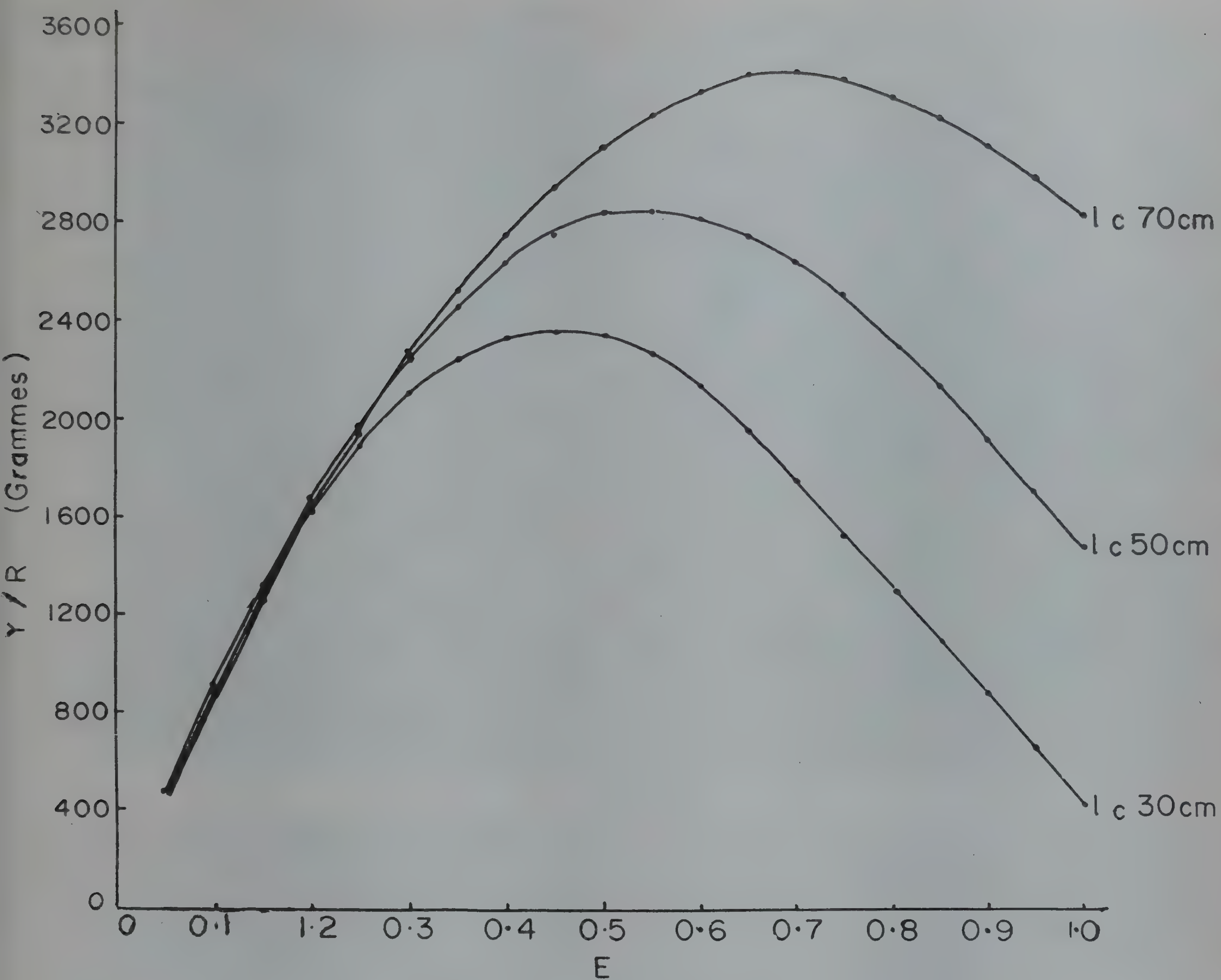

Fig. 3. Yield per recruit of *Thunnus albacares*

Species composition: Specisewise, the yellowfin tuna *(Thunnus albacares)* dominated the catches and accounted for 18,875.5 kg (46.17%) of the total catches. It was followed by skipjack *(Katsuwonus pelamis)* 11,106.3 kg (27.16%), sharks 7,558 kg (18.48%), *Elagatis bipinnulatus* 2677.8 kg and others.

Catch per unit effort: Average catch per unit of effort for the season as a whole from floatsam associated catches was 908.58 kg. The maximum catch per unit effort was recorded during October, being 1,593.05 kg and was followed by December (1,150.5 kg), September (1,040.33 kg), April (780.44 kg), May (722.83 kg), November (624.70kg) and the lowest of 507.67kg during January.

It is interesting to note here that average CPUE from floatsam catches was about three times higher than average CPUE for pole and line catches during 1982–'83 tuna fishing season. The reason is the availability of fishes in good concentrations around these floating objects.

Catch per floatsam object: The maximum catch of 3,451.5 kg per float was recorded during December followed by September (3,121 kg), October (2,228.6 kg), April (1,592.10 kg), May (1,445.67 kg), November (890.91 kg) and January (761.50 kg). The average catch per floatsam object for the season as a whole was 1,572.54 kg.

During 1984–'85 season tuna fishing associated with flotsam was noted to be five times, and wooden pieces mostly constituted the flotsam. It was observed that both *K. pelamis* and *T. albacares* along with *Coryphaena* sp.

Fig. 4. Pole and line fishing for tunas around Minicoy.

Fig. 5. Tuna landings.

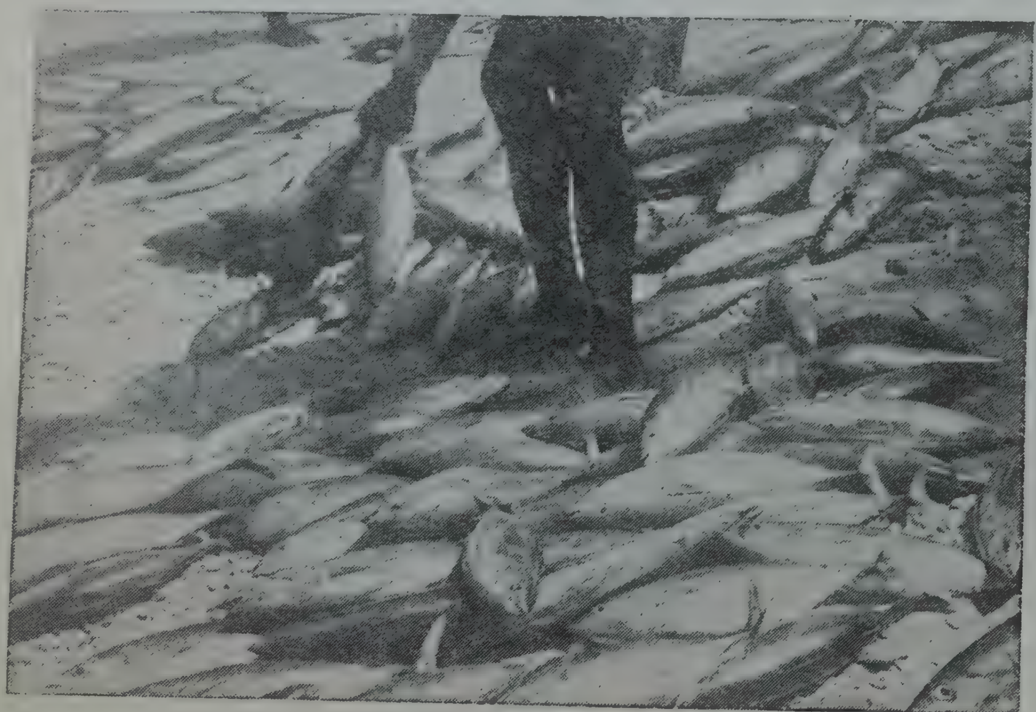

Fig. 6. A catch of skipjack being taken ashore.

Fig. 7. Regular biological studies are needed for proper management of fishery.

Fig. 8. Tunas being gutted at the landing centre.

Fig. 9. Tunas are taken for processing in the factory

Fig. 10. Tuna processing in progress.

Fig. 11. Canning tunas at a factory.

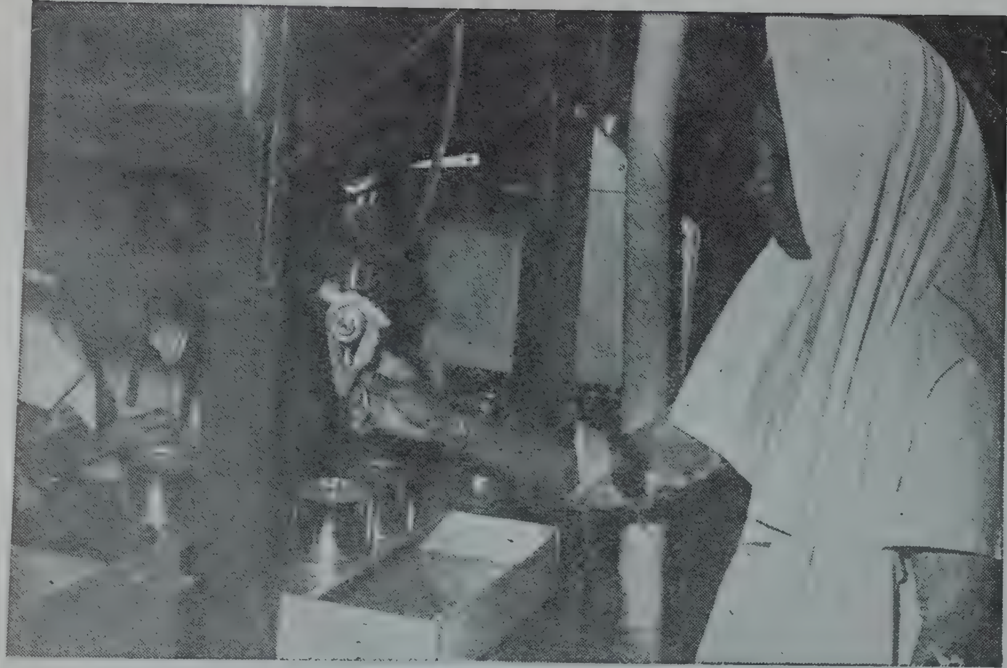

Fig. 12. Mechanical brine filling unit in operation.

Fig. 13. Tuna being dried in the open air.

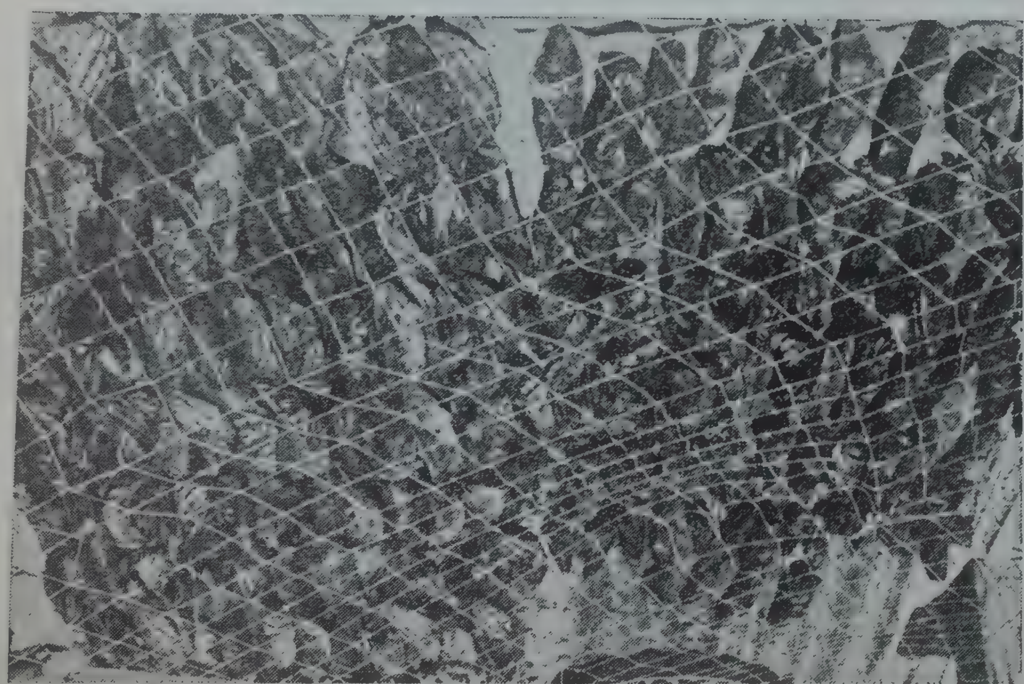

Fig. 14. *'Masmin'* – the cured and dried product of tuna.

Fig. 15. *'Masmin'* – ready for marketing.

and *Elagatis bipinnulatus* were taken. The catch per boat of fishing associated with the flotsam ranged from 256.7 kg to 1,159.9 kg and averaged to 580.2 kg. An interesting aspect noted in this type of fishing was that skipjack tuna associated with floatsam ranged from 320–570 mm and yellowfin tuna 310–560 mm.

Strategies for future development

George *et al.* (1977) estimated a projected exploitation potential of 50,000 tonnes of tuna from Lakshadweep. Silas and Pillai (1985) proposed that by 2000 AD the total production of skipjack and young yellowfin tuna should achieve a commercial production target of 150,000 tonnes.

The introduction of larger pole and line boats recommended by Silas and Pillai (1982) is particularly significant to the Lakshadweep islands. The fishermen are not able to go in search of tuna shoals outside the vicinity of the islands. For undertaking prolonged fishing trips and improvements in operational techniques, navigational aids and catch storage facilities will be of great advantage and would increase tuna production. In this connection it is worth mentioning that a Radio Beacon Station (320 KHZ) and a Radar transponder Beacon (RACON) (9300 to 9500 MHZ) are working at Minicoy light house. These navigational aids can be made use of by the fishermen with the help of simple Radio Direction Finder/rader equipments.

The scarcity of live-baits is no doubt a limiting factor for the expansion of the fishery. Research inventory on live-bait fishes including the assessment of the availability and abundance of live-bait resources in space and time, along with large scale culture of suitable live-bait fishes for supplying to the fishermen deserve special attention. In this context the proper management and conservation of the coral reef habitat which sustains the bait fishes are of prime importance.

The above aspects along with adequate improvements in post-harvest technology and marketing can go a long way in the development of pole and line tuna fishery at Minicoy Island.

EXPLOITED AND POTENTIAL RESOURCES OF LIVE-BAIT FISHES OF LAKSHADWEEP

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Introduction

Jones (1958) described tuna live-bait fishery of Minicoy in detail based on firsthand information collected by him during the voyage of M. V. *KALAVA* of the erstwhile Indo-Norwegian Project. Jones (1964) described 45 species of live-bait fishes belonging to 30 genera and 19 families which included all the major bait fishes, made a key for their identification and graded them according to their survival in captivity and chumming quality. A study of the monthly fluctuations in the occurrence of major tuna live-baits of Minicoy during 1960–'61 was carried out by Thomas (1964b). Silas and Pillai (1982) described in detail the live-bait for pole and line fishery and their fishing techniques, floating receivers and transportation and culture of bait fishes. Madan Mohan and Kunhi Koya (1986c) studied the biology of live-bait fishes *Spratelloides delicatulus* and *S. japonicus*.

FLUCTUATIONS IN LIVE-BAIT FISH CATCH

Fishermen of Minicoy Island do not maintain any record of the quantity of live-bait used in a particular tuna fishing season. They generally complain about the regular decline in the live-bait fish catches. To ascertain whether really live-bait catches are declining year after year, live-bait catch data (in kg) were collected during 1981–'82, 1983–'84 and 1984–'85 fishing seasons.

Only 124 kg of live-bait fishes were caught during November, 1981 which was the lowest catch for the tuna fishing season as a whole. The maximum catch of 803 kg was recorded during March, 1982 followed by February (795 kg), April (404 kg), January (362 kg) and December, 1981 with 308.65 kg. It can be seen that there was gradual increase in live-bait catches from November to March, 1982.

During 1983–'84 tuna fishing season, lowest catches of live-bait were recorded in March, 1984; being 310.5 kg. Maximum catches of live-bait were recorded in January (833 kg) followed by December (679.5 kg), November (559.5 kg), April (476.5 kg) and February (364.4 kg). Though live-bait catches increased from November to January, it declined in February and March and recovered to some extent in April.

During 1984–'85 season, maximum catches were recorded during March (1039.5 kg). The lowest catch was recorded during May (281.5 kg). During the other months the catch fluctuated between 333.5 kg and 909.5 kg.

Fishing effort: During 1981-'82 season 885 boat trips were made for collecting live-bait. While minimum number of boat trips were recorded during November (80 trips), maximum of 260 trips were recorded during February followed by March (164 trips), December (153 trips), January (147 trips) and April (81 trips). The live-bait catches improved with the increase in effort in some months, but in other months namely March and April less number of boat trips provided good quantity of live-bait.

During 1983-'84 season a total of 1,268 boat trips were made. Minimum number of boat trips were recorded during April; being 173, while maximum of 279 were recorded in January followed by November (241 trips), December (206 trips), February (191 trips) and March (178 trips). Monthly effort showed gradual increase from November to January and then declined gradually from February to April, 1984.

SPECIES COMPOSITION OF LIVE-BAIT FISHES

Lepidozygus tapeinosoma which used to be the main live-bait fish during tuna fishing season was not available at all during the period under study. During 1981–'82 seasons *Spratelloides delicatulus* dominated among the live-bait catches, contributing to 64.16% of the total catches. This was followed by *Archamia lineolatus* 22.23%, *S. japonicus* 9.40%, *Chromis caeruleus* 2.34% and *Caesio caerulaureus* 1.87%. During all the months of the season blue sprat, *Spratelloides delicatulus* ranked highest in availability among all the live-bait fishes. *Archamia lineolatus* was available though in less quantities than blue sprat during all the months of the season. *S. japonicus* and *Chromis caeruleus* were also collected of which the former was available in good quantity during January and February.

During 1983-'84 season, catches of *Spratelloides delicatulus* declined. Though this species again dominated the live-bait catches, it contributed only 32.68% of the total catches. This was followed by *Archamia lineolatus* (30.56%), *S. japonicus* (12.28%), *Caesio chrysozona* (8.24%), *Chromis caeruleus* (6.81%), *Pranesus pinguis* (6.26%), *Gymnocaesio argenteus* (2.56%) and *Caesio pisang* (0.62%).

As is clear from the above description the live-bait catches improved a little during 1983–'84 season in comparison with that of 1981–'82 season. While 2,798.65 kg of live-bait fish were caught during 1981–'82 season, it was 3,223.5 kg during 1983–'84 season with an increase of 43.28%. Catch per unit of effort declined from 3.16 kg in former season to 2.54 kg in 1983–'84 season. During 1984–'85 season, a total of 5,595.2 kg of live-bait fishes were caught. During 1981–'82 season, *Spratelloides delicatulus* formed the bulk of the live-bait catches, contributing 64.16% of the total catches. Other species which were caught in good percentage were *Archamia lineolatus* and *S. japonicus*. But during 1983–'84 season *S. delicatulus* and *Archamia lineolatus* contributed almost equally with 32.68% and 30.56% respectively. Other species which supported live-bait fishery were *S. japonicus* (12.28%), *Caesio chrysozona* (8.24%), *Chromis caeruleus* (6.80%) and *Pranesus pinguis* (6.26%).

Caesio chrysozona, Pranesus pinguis and *Gymnocaesio argenteus* which contributed to the betterment of the live-bait catches during 1983–'84 were not caught during 1981–'82 season at all. Since major live-bait fishes were not available and could not meet the bait fish demand during 1983-'84 season, about 550 kg of *Caesio chrysozona, Pranesus pinguis* and *Gymnocaesio argenteus* together were caught and used as live-bait.

During 1984–'85 season, a total of 12 species were recorded of which *S. japonicus* constituted 36.1%, *Caesio caerulaureus* 18.5%, and *C. chrysozona* 12.2% followed by other species (Table 1).

Table 1. *Species composition of tuna live-bait at Minicoy during* 1981–'82, 1983–'84 *and* 1984–'85 *seasons (Kg)*

Species	1981–'82	1983–'84	1984–'85
1. *Spratelloides delicatulus*	1,795.65	1,053.5	2,019.0
2. *S. japonicus*	263.00	395.0	435.0
3. *Archamia lineolatus*	622.00	985.0	—
4. *Chromis caeruleus*	65.50	—	119.1
5. *C. ternatensis*			41.5
6. *Caesio caerulaureus*	52.50	219.0	1,031.9
7. *C. chrysozona*		265.5	722.1
8. *C. pisang*		20.0	
9. *Gymnocaesio argenteus*		82.5	683.9
10. *Lepidozygus tapeinosoma*			26.0
11. *Apogon sangiensis*			118.7
12. *Rhabdamia gracilis*			63.0
13. *Archamia fucata*			98.6
14. *Dussumieria hasselti*			124.0
15. *Pranesus pinguis*		202.0	

OBSERVATIONS ON THE HABITS AND HABITATS OF TUNA LIVE-BAIT FISHES

Fishermen of Minicoy fully depend for their live-bait fish requirements on the lagoon which provides them a variety of fishes. It is a well known fact that at Minicoy some of the live-bait fishes appear in the lagoon all of a sudden, remain there for some days and then disappear. Some of the live-bait fishes reside inside the lagoon, while others enter the lagoon and support the fishery during tuna fishing season. Therefore, observations were made on the different habitats at the time of their availability in the lagoon.

Sprats

Spratelloides delicatulus: This species is locally known as 'Hodeli'. It is found in scattered shoals near the inner reef area at Ragandi point in the western part of the lagoon. It can easily be found on the shoal sand and coral flats near the clear and moving water and in shallow water area inside the fringing reef. It enters the Minicoy lagoon during the southwest monsoon and are fished during the tuna season. Only young and immature fish are caught and used as live-bait. Mature specimens in stray numbers can be caught from the coastal area of the lagoon.

S. japonicus: This species is locally known as 'Rehi' at Minicoy. It is found in the deeper part of the lagoon north of Ragandi point and are found associated with the corals. During high tide, this species gathers on the top of the coral heads but during low tide it moves to deeper waters away from the corals.

Apogonids

These are locally known as 'Bodi'. *Archamia lineolatus* accounts for more than 90% of the *Apogon* catches at Minicoy. This species lives around coral heads, mostly forming thick layer little away from the corals. They are found motionless in the deeper waters of Minicoy lagoon but whenever they are disturbed at the time of live-bait catching, they move for shelter among coral branches. These are available in the deeper waters in the central and northern part of the lagoon.

Pomacentrids

Few years back, *Lepidozygus tapeinosoma* (locally known as 'Bureki') used to enter Minicoy lagoon from December onwards. It was the most important pomacentrid which used to rank first in availability among all the bait fishes. But from 1981–'82 tuna fishing season onwards this species was not available. *Chromis caeruleus* (locally known as 'Nelamahi') which is now the major pomacentrid caught from the lagoon, is found closely associated with the corals in the southern part of the Minicoy lagoon and also in the deeper part of the lagoon.

Some other pomacentrids are also collected from near the coral colonies of the deeper part of the lagoon. They include *Dascyllus aruanus, Pomacentrus pavo, Abudefduf biocellatus* and *Abudefduf* spp. These species are available only as stray specimens along with the major live-bait fishes.

Caesio spp.

These are locally known as 'Mugurang'. They are found in the deeper area of the northern part of Minicoy lagoon, crevices and small caves of shallow reef area. They are caught during the latter half of the tuna fishing season from the Kodi point area and outer part of the lagoon and northern side of Ragandi point. Their occurrence is very erratic and every year one or the other species occur. For example *Caesio caerulaureus* was available during 1981–'82 season in good numbers but during 1983–'84 season *Caesio chrysozona* occurred in good quantity.

Atherina spp.

These are locally known as 'Fitham'. Two species are common at present, namely *Prenesus pinguis*

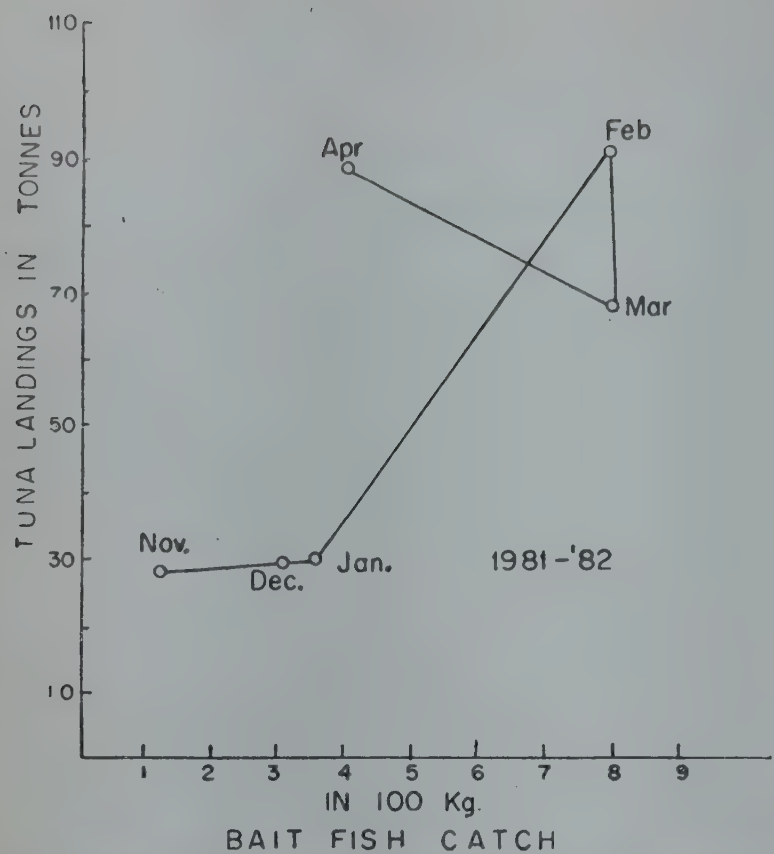

Fig. 1. Relationship between bait-fish catch and tuna landings at Minicoy, 1981–'82.

and *Stenatherina tamminck*i out of which the former formed the bulk of the catch. These are found near lagoon shore area specially where algal blooms occur. These are seen swimming near the Minicoy jetty and in a little deeper part of the lagoon. *Atherina* spp. were caught in good percentage and used as live-bait during 1983–'84 season.

Other live-bait fishes

Two species of mullets, namely *Crenimugil crenilabis* and *Velamugil seheli* are found along sandy beach area. Usually *Atherina* and mullets are found together. Some of the parrot fishes like *Helichoeres* spp. juveniles of *Thalassoma* spp. are found associated with corals in shallow water area. They are caught and used as bait during the end of the tuna fishing season.

BIOLOGY OF LIVE-BAIT FISHES AT MINICOY

While collecting data on live-bait fish catches at Minicoy during 1981 to 1984, it was felt that investigation on the biology of major live-bait fishes is of prime importance. Biological studies on the length-frequency, age and growth, sex and maturity, and feeding were carried out on *Spratelloides delicatulus, S. japonicus* and *Pranesus pinguis*.

Spratelloides delicatulus: Studies on this species are based on material collected during 1981–'82. Total length of the individual fish ranged between 18 and 59 mm. Based on the length-frequency studies, the length of the one year old fish was estimated to be 46 mm. Since bigger specimens of more than 59 mm long were not available during the year as a whole, it can be stated that fish are available upto 1+year age.

Specimens with six stages of maturity were recorded during the studies. Spent specimens were not available. Ripe group of ova ranged in diameter from 0.47 mm to 0.71 mm with mode at 0.56 mm. The species spawn during southwest monsoon season which may extend upto December and because of this young fishes are available from October to April. Sex ratio of males to females was found to be 1:0.79. The fish spawn more than once in a spawning season. Number of mature ova in an ovary ranged from 286 to 1,005 when 15 ripe ovaries were examined.

The food of this species was composed mainly of crustaceans which were represented by post larvae of decapods, copepods mainly herpacticoides and calanoides, mysids, gammarids, fish eggs and algal filaments.

S. japonicus: Since this species is available usually for a few months only during the tuna fishing season

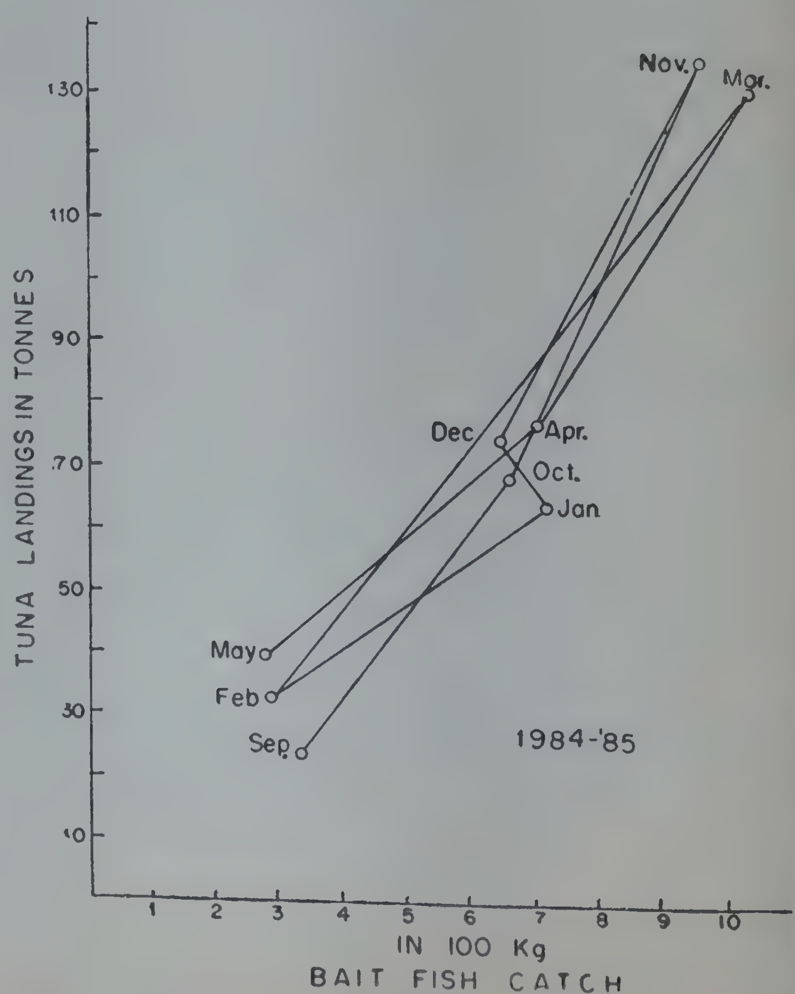

Fig. 2. Relationship between bait-fish catch and tuna landings at Minicoy, 1984–'85.

at Minicoy, a few samples from December, 1981 to March, 1982 were collected and studied.

Total length of the individual fish ranged between 35 and 60 mm. The length data are available for a few months only. But since they resemble *S. delicatulus,* in growth pattern, it is estimated that *S. japonicus* also will be about 46 mm long when it becomes one year old.

Six maturity stages in males and females were identified. Spent specimens were not available. Ripe ova ranged in diameter between 0.38 mm to 0.56 mm with mode at 0.42 mm. Since mature ovary contains three types of ova namely immature, maturing and mature, it can be stated that fish may spawn more than once in a spawning season. Number of mature ova in a mature ovary ranged from 381 to 1,181. Ratio of males to females was found to be 1:0.71.

Pranesus pinguis: This species is used as live-bait generally towards the end of the tuna fishing season. It was collected from the shore area of lagoon for biological investigations. A total of about 1,325 specimens were collected and biological parameters studied.

Total length of the individual fish ranged between 12 mm to 102 mm. Young fishes of about 40 mm in length were available in the samples throughout the year.

Fishes of seven stages of maturity were available; sometimes in one sample itself. During both the years indeterminates made bulk of the specimens examined. Since mature fishes are available along with spent specimens and indeterminate young fishes throughout the year, it can be concluded that *Pranesus pinguis* spawns throughout the year in the Minicoy lagoon itself.

This species is very hardy during transportation and is supposed to be the second best live-bait in Hawaiian islands in Pacific Ocean. But at Minicoy this is used as live-bait when other major live-bait fish are not available. During 1983–'84 season a good amount of this species was used as live-bait.

STUDIES ON THE COMPARATIVE EFFICIENCY OF LIVE-BAIT FISHES

Different fish species associated with corals are used as live-bait at Minicoy. Whichever species is available in good numbers are made use of as live-bait. But only a few of them are considered superior for pole and line operations. A live-bait fish can be more successful on one occasion in a particular area than at others. Therefore based on species-wise live-bait catch and tuna catch data, relative effectiveness of major live-bait fishes was studied during 1981–'82 and 1984–'85 seasons.

Since *Spratelloides delicatulus* formed bulk of the live-bait fish catches with reasonably good average tuna catch per unit of live-bait for the season, it was taken as standard bait to work out the relative effectiveness of other live-bait fishes. Average CPUB of other individual species was divided by the average CPUB of *Spratelloides delicatulus* for this purpose. Relative efficiency of *Archamia lineolatus* was calculated as 1.38, *S. japonicus* 1.53, *Chromis caeruleus* 0.49 and for *Caesio caerulaureus* 0.85.

For *Spratelloides delicatulus* CPUB ranged from 39 kg to 76.4 kg with an average of 62.53 kg for two seasons. For *Archamia lineolatus* CPUB varied from 55 kg to 239 kg with an average of 86.3 kg for the two seasons. For *S. japonicus* it ranged from 41 kg to 400 kg with an average of 95.57 kg. For *Chromis caeruleus* it ranged from 23 kg to 116 kg with average of 31 kg. For *Caesio caerulaureus* CPUB ranged from 14 kg to 64 kg with an average of 53.10 kg.

But there are some factors which can effect tuna catch per unit of bait such as size and species of tuna caught, number of men fishing, size and number of fish per one kilogram of live-bait, relative abundance of tunas and above all response of tunas to live-bait fishes.

Though *Spratelloides japonicus* proved to be the most efficienct live-bait fish during 1981–'82 season followed by *Archamia lineolatus,* the former species contributed only 9.40% to the total live-bait fish catches and latter 22.23%. *Spratelloides delicatulus* with CPUB of the 62.53 kg also proved good in efficiency and it contributed 64.16% of the total live-bait catches and was available to tuna fishing boats during all the months of 1981–'82 season.

STUDIES ON CORRELATION AMONG LUNAR CYCLE, LIVE-BAIT AND TUNA CATCHES AT MINICOY

It is believed at Minicoy by the local fishermen that some live-bait fishes appear in the lagoon during certain phases of the moon and after that live-bait catches generally show decreasing trend. There was no record of

Fig. 3. *Spratelloides delicatulus*

Fig. 4. *Rhabdamia gracilis*

Fig. 5. *Apogon sangiensis*

Fig. 6. *Gympcaesio argenteus*

live-bait fish landings at Minicoy prior to 1981. This study was undertaken during 1983–'84 season to see whether moon phases are really playing an important role in the availability of live-bait fishes in sufficient quantities at Minicoy.

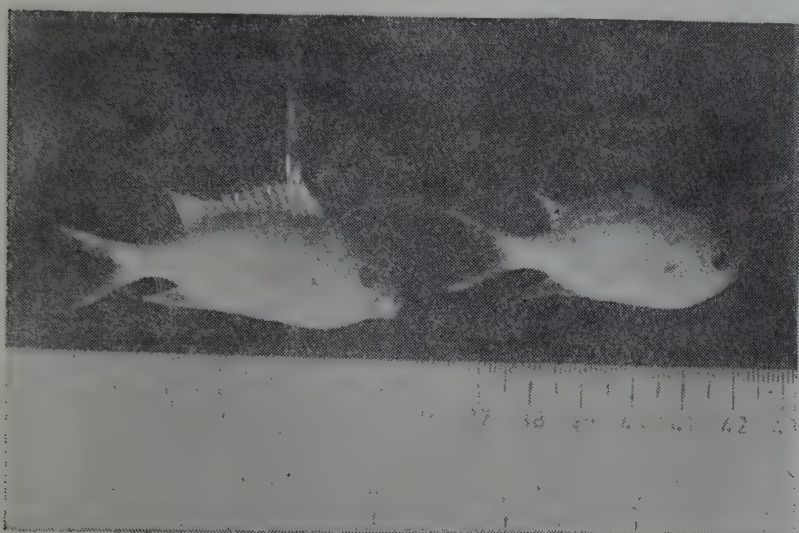

Fig. 7. *Chromis caeruleus*

By this study, the dependence of live-bait fish and tuna catches on the four phases of moon namely new moon, first quarter, full moon and last quarter during 1983–'84 tuna fishing season has been demonstrated. Out of the six months of fishing season, live-bait fish catches were higher during new moon phase in four months but when considered for the whole season, the live-bait catches and tuna catches were greatest during new moon phase and lowest in last quarter. Tuna catches per kilogram of bait fish were found highest during the last quarter and lowest during new moon phase. Effort for live-bait fishing and tuna fishing, and catch per unit of effort of live-bait fishes and tunas were highest during new moon phase and lowest in the last quarter.

LIVE-BAIT FISH REARING EXPERIMENTS

At Minicoy, specimens of *Chromis caeruleus* were collected from the southern part of the lagoon and were brought to Research Centre laboratory for rearing experiments. They were kept in plastic aquarium tanks and were reared for about three months by providing them supplementary food. They were fed by crab body parts, fish flesh and occasionally zooplankton.

Since the catch of *Chromis* sp. is diminishing year after year, there is an urgent need to protect this bait fish resource by their large scale production. The survival of this species in captivity has opened up the way for the planning of its large scale rearing.

The relationship between tuna catch and live-bait fish landings during the period 1981–'82 and 1984–'85 are presented in figures 1 and 2. It is very clear from the figures that a positive relationship exists between the total landings of tunas and live-bait fish catch.

PRESENT STATUS OF LIVE-BAIT FISHERY IN MINICOY

Pillai (1983 and 1985) described in detail the ecological crisis in the Minicoy lagoon.

There is a general feeling among the fishermen of Minicoy that the live-baits are not as plenty at present as they used to be in the past. The condition at the other islands is not fully realised. To obtain the views of a few well experienced fishermen, the CMFRI interviewed them and their opinions were taken into consideration, as a prelude to an attempt to find a scientific interpretation of the problem.

It is rather difficult at this stage to find, figure-wise, any decline in the live-bait catches at Minicoy or at

Fig. 8. Floating basket for tuna live-baits

other islands in the recent past due to non-availability of much needed quantitative data over the span of many years. Such data collected by the CMFRI at Minicoy during the fishing season 1981–'82, 1983–'84 and 1984–'85 show that the catches of live-baits were in the order of 2,799 kg, 3,224 kg and 4,270 kg respectively. These catches were mainly sustained by *Spratelloides delicatulus* (64.2%), *S. japonicus* (9.4%), *Archamia lineolatus* (22.2%) and *Chromis caeruleus* (2.3%) in 1981–'82 season; by *S. delicatulus* (32.7%), *A. lineolatus* (30.6%), *S. japonicus* (12.3%) *Caesio chrysozona*

(8.2%), *Caesio caerulaureus* (6.8%), *Pranesus pinguis* (6.3%) and *Gymnocaesio argenteus* (2.6%) in 1983–'84 season and by *S. delicatulus* (36.1%), *C. caerulaureus* (18.5%), *C. chrysozona* (12.9%), *G. argenteus* (12.2%) and *S. japonicus* (7.8%) in 1984–'85 season. However,

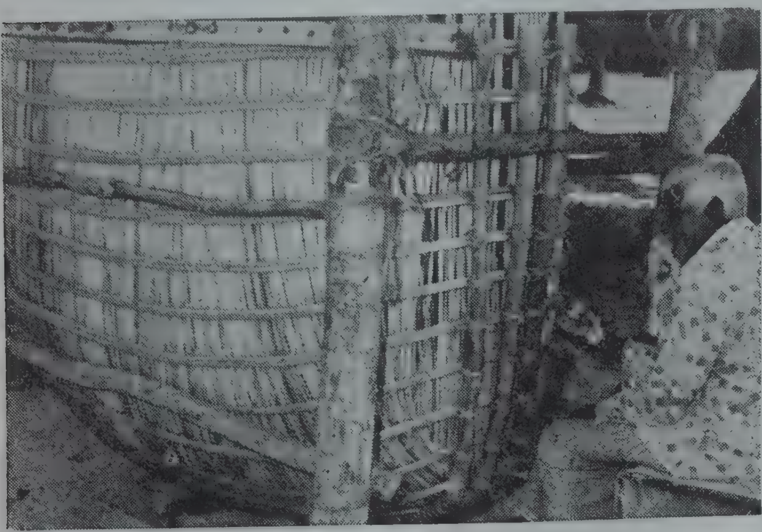

Fig. 9. Tuna live bait basket

the fact remains that the demand for live-baits now-a-days exceeds the fishable stock in the atoll regions. At least, three major reasons can probably be attributed to this shortage.

(a) *Environmental deterioration:* This has been dealt with in detail in another article in this issue by C. S. Gopinadha Pillai and Madan Mohan (P. 33).

(b) *Fluctuations in the seasonal recruitment of migrant bait fishes:* The recruitment of live-bait fishes to a small geographic area like Minicoy and other islands as well involves an element of chance mostly controlled by the meteorological conditions. For the last three or four years some of the important live-baits such as *Lepidozygus tapeinosoma* which was considered as much prefered and abundant live-bait in the earlier period (Jones, 1964 a and Thomas, 1964 b), have not entered the lagoon in any appreciable quantities. This, along with the seasonal fluctuations in the recruitment of the other migrant species belonging to *Spratelloides* and *Caesio* as evident from the catches of the bait fishes, form another reason for the recent probable paucity of live-baits. The migratory forms have exerted much pressure on the available stocks of resident forms. It is also probable that the deterioration of the habitat is not conducive for the proper survival of the new recruits of the resident species.

(c) *Demand exceeds available stock:* A third reason which is of much significance on the reported dwindling of live-baits seems to be over exploitation of the resources consequent on the introduction of mechanised vessels in pole and line tuna fishery in most of the inhabited islands of Lakshadweep. This fleet which consisted of nine boats in 1963 has increased to 94 boats in 1973 and to 263 in 1983. This has resulted in the increase in the production of tuna by the pole and line fishery from about 566 tonnes in 1963 to 1,020 tonnes in 1973 and to a record production of 3,037 tonnes in 1983. There is, thus, certainly a greater demand for the live-baits than in the past; and the fishermen exploit the available resident species to the possible level. This is very clearly observed in the case of *Chromis caeruleus,* a species which was very dominant throughout the lagoon of Minicoy till the beginning of 1980 started dwindling thereafter. Similar situation probably prevails at Agatti, Androth, Bitra, Kavaratti and Suheli as could be judged by the increased tuna production by the mechanised pole and line fishery.

The cumulative effect of these, is an apparent shortage of live-baits not only at Minicoy but probably also at the other islands of Lakshadweep. It is to be watched whether the situation will improve by the increased recruitment of the non-resident migratory species. The chances of resident species showing improvement appear to be very little, because of the deterioration of the environment caused by human interference.

Errata based on subsequent communication

1. Page 27, Table 1. The species name *Archamia lineolatus* may be deleted.
2. In the same Table the catch details given against *Archamia lineolatus* are referable to *Archamia fucata.*
3. Page 27, column 1, para. 2, line 2. 'Hodeli' may be read as 'Hondeli'.
4. Page 28, column 1, line 1, *Stenatherina tammincki* may be read as *Stenatherina temmincki.*
5. Throughout the article *Archamia lineolatus* may be read as *Archamia fucata.*

ECOLOGICAL STRESS IN MINICOY LAGOON AND IT'S IMPACT ON TUNA LIVE-BAITS

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Introduction

Pioneering works on the faunal composition and exploitation of tuna live-baits of Lakshadweep, especially of Minicoy Island are those of Jones (1958, 1960a, 1960b, 1964a) Jones and Kumaran (1980) and Thomas (1964b). subsequently Pillai (1971a, 1971b, 1983 and 1985) and Nair and Pillai (1972) have described the microhabitats, distribution of corals, ecological stress and primary production in the Minicoy lagoon, a major habitat for live-baits. Though, Jones (1964) listed 45 species of reef associated fishes divided among 18 families from Lakshadweep which are used as live-baits, only about 10 species are of common use (Thomas, 1964b). Inspite of all these earlier works, many aspects of the ecology and biology of reef fishes from Lakshadweep remained unknown. In the present communication the authors make an attempt to throw more light on the above aspects especially on the impact of ecological stress in the Minicoy Lagoon on the tuna live-baits.

Major reef fish habitats in Minicoy

The major habitats for reef fishes in Minicoy include the reef flat, reef front, inner lagoon reef, lagoon shoals and sand flat. The reef fronts of Minicoy or any other atoll of Lakshadweep provide rich ground for both small and large fishes. The littoral reef flats have been recently studied for their fin fish and shell fish resources (Pillai *et al.,* 1984). The microhabitats on both windward and leeward reef flats include dead coral boulders with or without algal coating and live corals. The upper and midlittoral reef flats present significant variation in the structure and composition of resident fishes. The rock pools form the primary settling sites for many reef fishes during November to April. Both herbivorous and carnivorous fishes make diurnal migration over the reef flat along with the tide. These fishes move to the upper littoral flats at high tide and feed on the rich source of food items and return along with the receding tide. The live corals on the reef flats also harbour many resident reef fishes as in the lagoon. A relative paucity of fish fauna on the windward reef flat was also observed during the present observation. Pillai *et al.,* 1984 explained this as due to relative absence of living habitats by way of dens and crevices at the protected side.

The lagoon possesses two ecologically distinct habitats, viz, coral shoals and sand flats (Pillai, 1971). The former provides habitat for many important live-baits belonging to the families Pomacentridae and Apogonidae and form the traditional site of live-bait fishery. The southern half of the lagoon has a vast sand flat with smaller shoals and live coral isolate. The arborescent corals of the genus *Acropora* once dominated in this area. Except for *Spratelloides* the area is not important as a site of fishery.

Live-baits and their microhabitats in lagoon

The lagoon fishes in general can be classified into either resident or migrants. Those that are found on coral heads are resident, while those that sporadically appear in the lagoon waters are migrants.

Fig. 1. A Reef flat in Minicoy. Beneath the waves there is a profusion of fish life.

Live coral associates

The association between coral reef fishes and corals is more or less specific. The growth-form of corals

seems to be a controlling factor. Inherent and physiological factors may also be involved. Only important live-baits and their specific habitats are considered herein:

a) **Corymbose, pedicellate corals with reticulately coalescent branches**

The common species with this growth-form belong to the genus *Acropora* and include *A. corymbosa, A. hyacinthus A. efflorescens* and *A. granulosa*. The following are the common live-baits found in these corals.

Family: Apogonidae

The genera *Apogon, Pristiapogon* and *Archamia* constitute the largely exploited fishes. Yet another species that is found along with them is *Spratelloides japonicus*.

Archamia fucata (Local name 'Rybodi'): The species is found either hiding among the coral colonies or swimming close to them. Probably their settlement on corals along with other apogonids takes place soon after the monsoon. Exploited stock during January to April include post-larvae and juveniles.

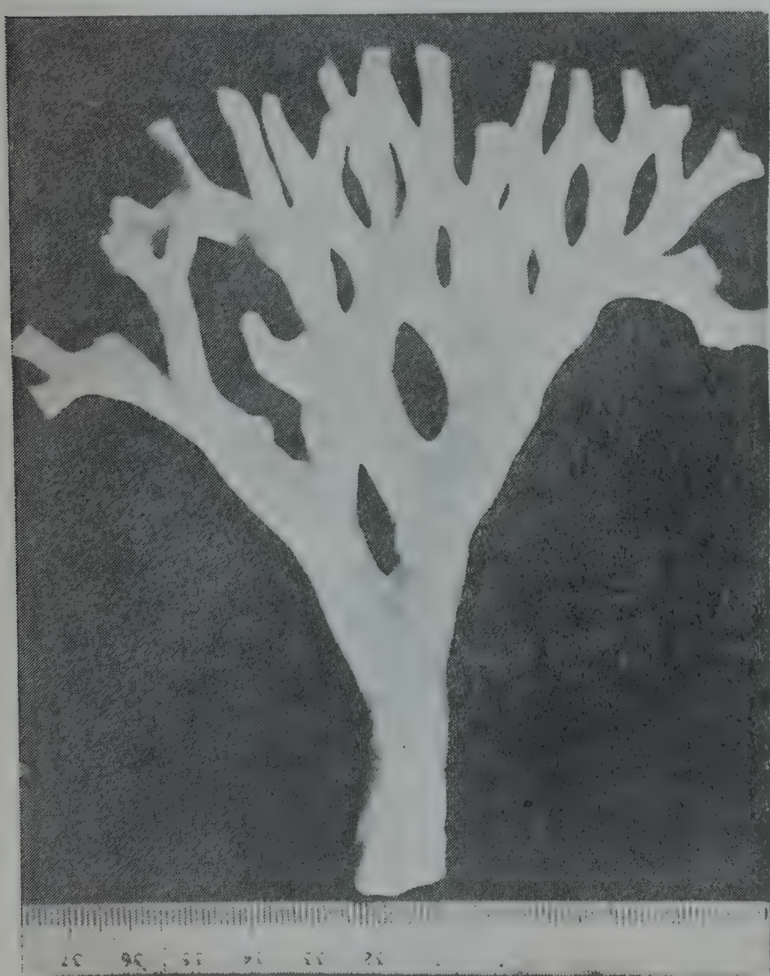

Fig. 2. Millipora – a hydroid coral.

Apogon sangiensis and *A. leptacanthus* (Local name: 'Rybodi'): Though both the species are found along with *Archemia*, of recent these are found on live massive corals also. Whether this is an adaptation in response to deteriorating primary habitat is yet to be assertained. It is known that for example, *Dascyllus aruanus*, may

Fig. 3. *Heliopora caerulea* a very dominant coral.

opt for dead corals in the absence of live corals. Both the species are planktivorous and exploited stock constitutes juveniles.

Pristiapogon fraenatus (Local name 'Murakibodi') and *P. synderi* (Local name: 'Bodu bodi'): The habit and habitat of these two species is almost similar to that of *Apogon* spp.

b) **Ramose arborescent and flabellate corals**

The dominant species of corals with the above growthform include, *Acropora formosa, A. teres, A. aspera, A. palifera, A. humilis, Stylophora pistillata, Pocillopora damicornis, Porites andrewsi, P. minicoiensis* and *Heliopora caerulea*. The blue coral *H. caerulea* is essentially an inner lagoon reef form while the rest thrive in the south and central part of the atoll often forming large thickets. The important associated fishes of this habitat belong to the family pomacentridae.

Family: Pomacentridae

Chromis caeruleus (Local name 'Nilamahi') and *Dascyllus aruanus* lead a co-existing life on ramose arborescent corals (Pillai *et al.*, in press). While the former serve a steady supply of live-baits in Minicoy, the latter is not of any value. *Pomacentrus pavo* is yet another species found along with *C. caeruleus* especially in the central part of the lagoon. This is also fished along with *C. caeruleus,* a strictly resident species with a pelagic post-larval life.

c) The surface waters of the lagoon

A few species of small fishes enter the lagoon at sporadic intervals as juveniles and are caught if and when available. None the less, they form a major component of the live-baits of Lakshadweep though their appearance is unpredictable and there is a lot of inconsistence in their recruitment to the fishery. Often their massive recruitment is coupled with a bumper catch of tunas. It is likely that tunas follow this group of fishes along with the oceanic current. Though tunas never enter the lagoon, the live-baits make their way into the calm lagoon waters along with the water current. The following are the major species listed under this category.

Family: Emmelichthyidae

Dipterygonotus leucogrammicus (Local name: 'Dandimugurang') is the most common species of this family. Some observations on the habit and habitat of this species were already made by Thomas (1964b.) and Jones and Kumaran (1980). This fish enter the lagoon between December and April. The first recruits are juveniles or post larvae. The adult habitat around Lakshadweep needs further investigation.

Fig. 4. *Fungia fungites*, a solitary coral-oral view

Family: Caesiodidae

Caesio chrysozona and *C. caerulaureus* (Local name: 'Furrua') are among the important caesiodids that enter the lagoon as juveniles and fished as live-baits.

Family: Pomacentridae

While *Chromis caeruleus* of this family is a strictly resident form, *Lepidozygus tapeinosoma* (Local name: 'Bureki') is almost a pelagic migrant soon after the monsoon season. There was a paucity of this species at Minicoy during 1981–'84 period.

The statement in early literature that most of these pelagic forms disappear from the lagoon after April needs confirmation. Generally, the lagoon remains choppy after May, and till end of November there is no fishing activity in the lagoon. Hitherto no effort has been made to survey the lagoon all through the year. Madan Mohan was able to collect some fully matured spratelloids from the near shore area during the monsoon which indicates that these pelagic forms of live-baits also may not altogether disappear from the lagoon soon after the tuna season or at the onset of monsoon.

d) Sand flat - lagoon bottom

Spratelloides delicatulus (Local name: 'Hondeli') of the family Dussumieriidae lives on the sandy bottom of the lagoon. Some times they swim to the surface and when scared make gliding movements in the air. The species is a planktivorous one and form an important source of live-bait. There is a preponderance of this species near Boaz Point (Ragandi Is.) and Viringili Island.

Ecological stress and its impact on live-baits

The lagoon environment of Minicoy has undergone visible changes in the last decade due to both natural and artificial factors (Pillai, 1983, 1985). The current prevailing feeling among the fishermen is that the live-baits are on a declining trend and the available stock is insufficient to meet the local demand. There are several factors responsible for this crisis of which the visible changes brought about in the environment are of prime importance.

Environmental deterioration

At present the lagoon of Minicoy is a modified ecosystem compared to that of a decade ago. Corals

Fig. 5. *Acropora abrotanoides* an arborescent coral predominant in the lagoon.

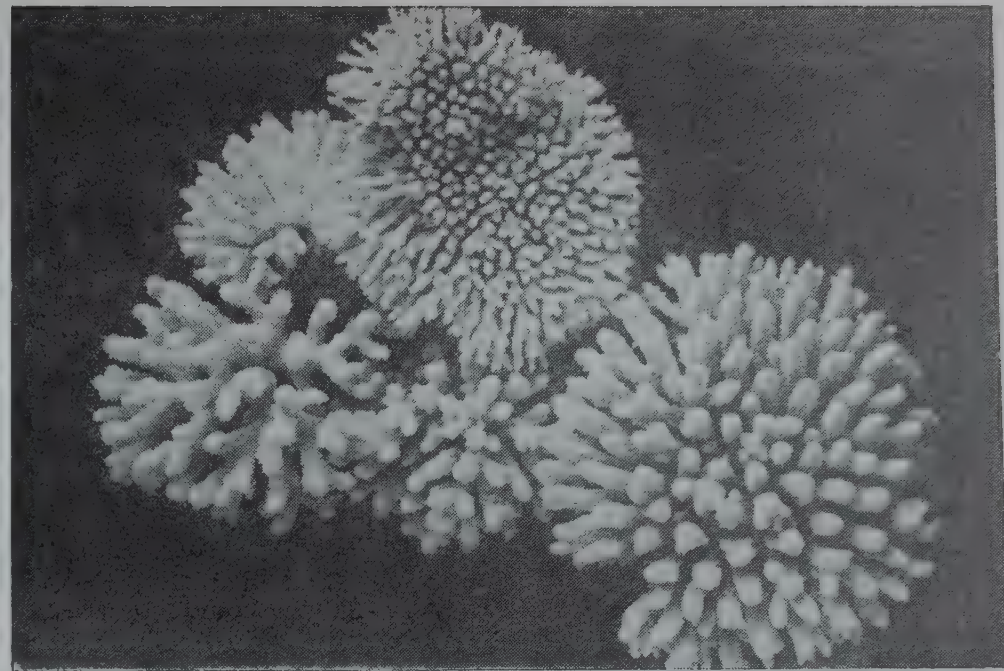

Fig. 6. A few common *Acropora* spp. corals from Lakshadweep that form the microhabitat for the resident reef fishes including the live-baits.

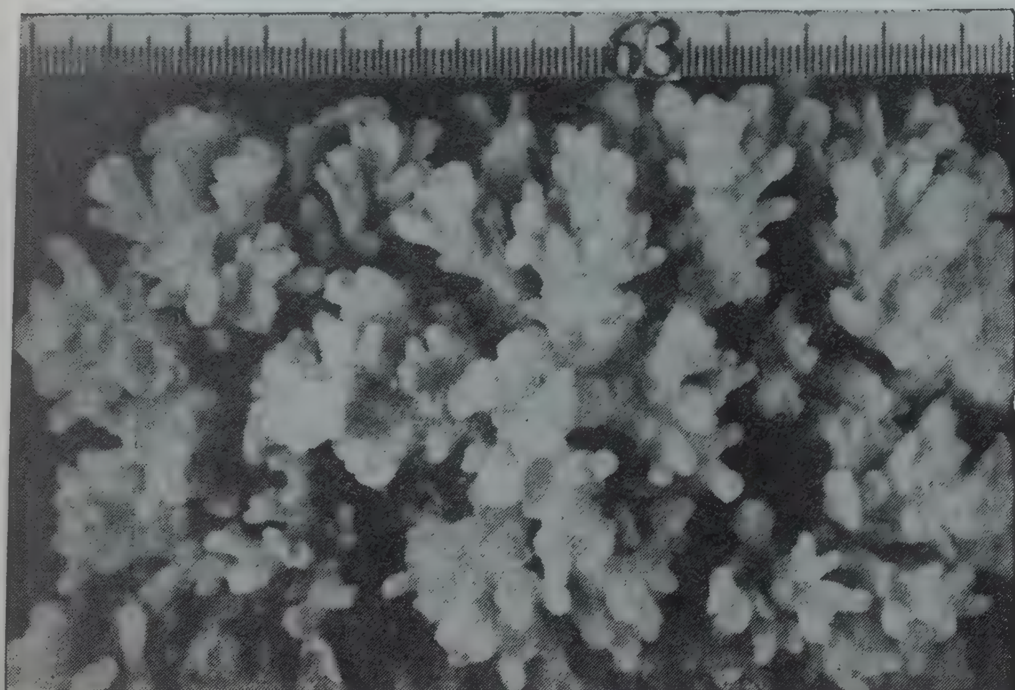

Fig. 7. *Pocillopora damicornis* – the most common Indo–Pacific coral that thrives both on reef flat and lagoon.

Fig. 8. *Acropora palifera.* Once this species dominated in the lagoon but now mostly dead due to siltation.

of all genera and species have suffered mass mortality during the last five or six years (Pillai, 1983). The large number of *Acropora* thickets that formed the habitat of many reef fishes including live-baits are all dead and are getting disintegrated. The lagoon bottom is strewn with dead branches and is slowly getting covered by sand. The major reason for this mass mortality of corals is undoubtedly excessive siltation. The blasting

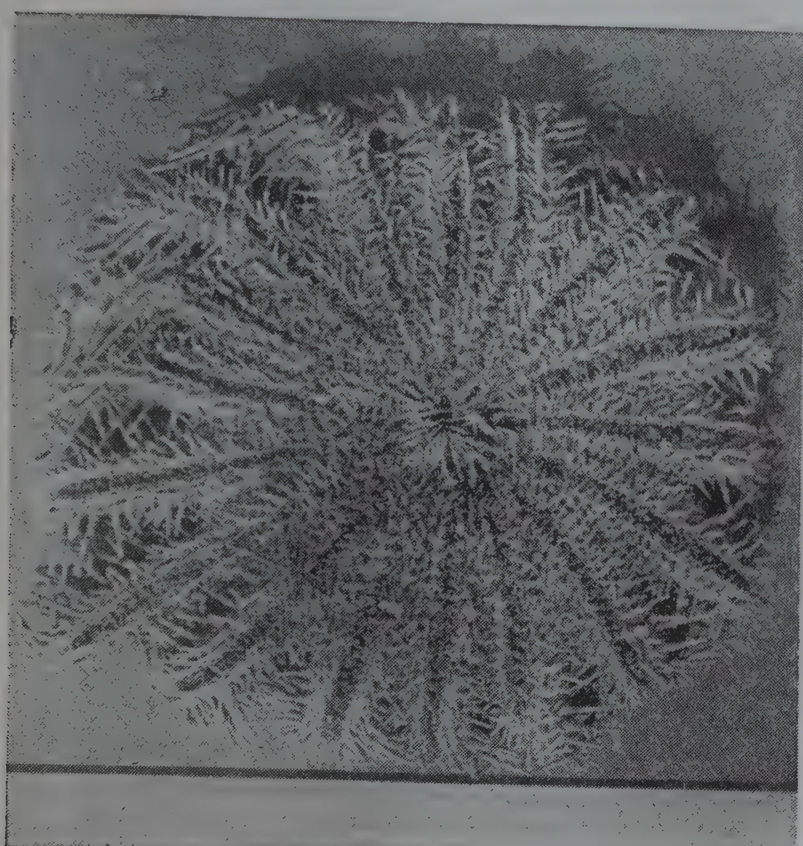

Fig. 9. *Acanthaster planci* — a star fish which feeds on the polyps of corals and destroys them (Photo courtesy: D. B. James)

of the reef and lagoon shoals as well as dredging the lagoon to deepen the boat channel have caused stirring up of sand and its transportation towards the southern half of the lagoon from the north along with the water current. At the southern half of the lagoon at least there is fresh deposit of 50 cm thick sand as estimated from the height of *Acropora palifera* colonies measured in 1968 which are at present buried intact.

Sea erosion is rampant and the blasting of the reef and deepening of the lagoon bottom at the northern entrance has certainly permitted greater influx of water into the lagoon. A greater degree of accretion is evident near the Light House area. The lagoon at the southern half is getting filled up rapidly. The dead ramose corals are efficient sediment trappers which aid the filling up of the lagoon. Small polyped corals like *Acropora* are very sensitive to the smothering effect of sediments and are easily killed (Pillai, 1971b).

In 1980, *Acanthaster planci* was also recorded in fair numbers among the *Acropora* thickets and several patches of freshly killed corals were observed (Murty *et al.*, 1980). The mass mortality of corals has adversely affected the resident ichthyofauna. The dominant resident species such as *Chromis caeruleus, Pomacentrus pavo* and *Dascyllus aruanus* have deplorably dwindled in the lagoon and the present lagoon looks depopulated when compared to a decade ago.

Habitats and recruitment of pelagic species

Fluctuation in the rate of recruitment of reef fishes to specific habitat is an established phenomenon. The settlement of fish larvae on their specific microhabitat depends on many factors such as breeding season, lunar periodicity in spawning, survival of larvae, species composition of the adult fish assemblage, force and direction of water current and natural tendency for precise microhabitat selection of the species (Sale *et al.*, 1984). At least some of these factors along with the conditions of the habitat are in operation in the Minicoy Atoll.

Except for a single known species of reef fish viz. *Acanthochromis polyacanthus* all reef fishes are believed to have a pelagic larval life (Sale, 1980). The pelagic life varies from two weeks to three months depending on the species and at the end of the pelagic phase they should settle on the specific microhabitat. Some species may be able to prolong their post larval pelagic life and undergo sexual maturity as in the case of *Ctenochaetus strigosus* when failed to get foothold on the reef (Pillai *et al.*, 1984b)

In resident species such as *Chromis caeruleus, Dascyllus aruanus, Apogon* and *Pristiapogon* spp. the major ecological constraint is the dwindling of living space due to mass mortality of corals (Pillai, 1983). Even if the larvae of these resident species enter the lagoon, their precise microhabitat requirement is a major controlling factor in their settlement and growth. Sale *et al.* (1984) have recently shown how some of the pomacentrids settle more profusely on wider live coral coverage than on area with sparse coral coverage. This indicates that intensity of coral growth is a factor that determines the settlement of coral reef fishes including tuna live-baits in many cases.

STATUS OF CORAL REEFS IN LAKSHADWEEP

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Historical

The Lakshadweep still remains to be one of the least studied group of islands in the Indian Ocean for its coral reefs and reef resources. The area is biologically significant in view of its isolation from major continental coastline as well as for its rich and varied marine life. The early studies on the reefs of Lakshadweep are those of Gardiner (1903, 1906) from Minicoy which include detailed descriptions of the reef and some reef corals. Alcock (1902) the surgeon naturalist visited several islands in the Laccadives (Lakshadweep) at the end of the last century. Though his visits to the islands were of short duration he left short but graphic description of many atolls mostly based on Admirality Charts. The islands were re-surveyed by Lt. Comm. C.G. Francis from the survey ship *Sutlej* (Charts by Indian Naval Hydrographic Office, Dehradun). A consolidated report on the icthyofauna by Jones and Kumaran (1980) is the most significant contribution from this area. Pillai (1971a, 1971b, 1982, 1983) Pillai *et al.* (1984) and Nair and Pillai (1972) furthered our knowledge of the various aspects of the reefs of Minicoy in the last more than one decade. A team of scientists from Central Marine Fisheries Research Institute made a detailed study of the fauna and flora of Kiltan Atoll in 1974 in connection with a major oil spill. The above resume of work on the reefs of Lakshadweep indicates that except for some useful information from Minicoy and Kiltan, ie. the extreme south and north of the archipelago, the area remains largely unknown for its reefs and reef resources.

THE REEFS OF LAKSHADWEEP

Morphology: The Lakshadweep has twelve atolls, three reefs and five submerged banks with a total of 27 islands. The total land area is 32 km² and the total extent of lagoon is about 420 km² (Mannadiar, 1977). Most of the islands are located on the windward reef flat at the eastern side. Raised reefs as far as known are found in Kiltan Atoll indicating a relative change in the level of land with sea in this area in the geological past. The surface morphology of Minicoy finds a place in Gardiner's (1903) extensive work, on the fauna and geography of Maldives and Laccadives. Silas *et al.*, (unpub.) have studied the surface morphology of the reefs of Kiltan Atoll (Long. 73°E, Lat. 11°29′N). The windward reef flats of both these islands have well developed algal ridges and spur and grove system. The supralittoral and littoral fringes are mostly devoid of any live corals though the rock pools may harbour isolated coral colonies. The windward reef flats are studded with huge lime stone masses which are under different stages of erosion. This should represent the remnants of elevated reef flat which were later subjected to heavy wave action.

Formation: According to Alcock (1902) "All Laccadive islands appear to be the remains of eroded atolls, raised only a few feet above the sea level and formed entirely of coral rock and coral sand. They rise quite abruptly from the sea that within half a mile of the shore often close upon 1000 fathoms deep." According to Gardiner (1903) the Maldives and Laccadives were formed on a large bank which was part of an ancient land that completely sunk. He also felt that some of the islands are remnants of mountains that existed in the sunken land. The two archipelagoes are located at the northern end of the north-south alinged submarine Laccadive – Chagos ridge. Lakshadweep is located on a large linear aseismic ridge which is made of massive coral capping on massive volcanoes. This volcanism

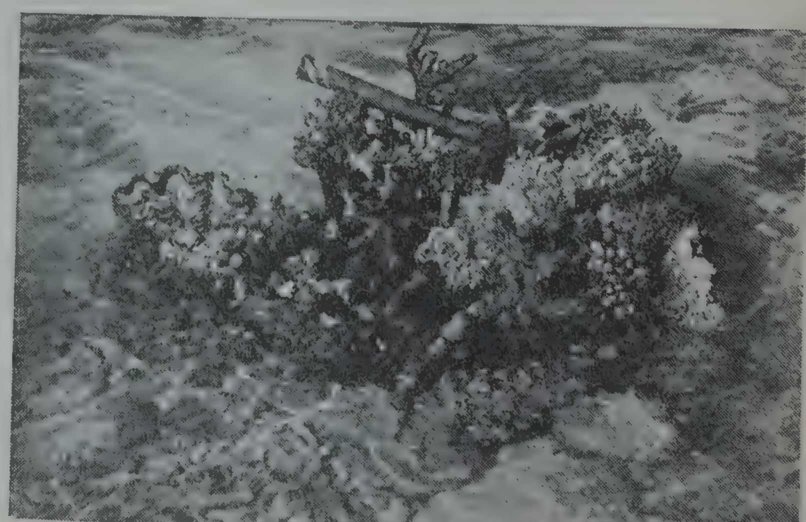


Fig. 1. A closer view of dead corals lying at the lagoon bottom. Also note dead *insitu* specimens of giant clam *Tridacna maxima.*

is probably Paleozoic -Eocene in age (Stoddart, 1973), No deep drilling has been hitherto made on the Lakshadweep reefs proper to estimate the thickness of coral capping. However, based on geophysical data the thickness in western Indian Ocean including Saya de Malha and Amirantes and Great Chagos Bank is estimated to be between 0.6 to 1.7 km (Glennie, 1936). In general confirmity with the geological history of

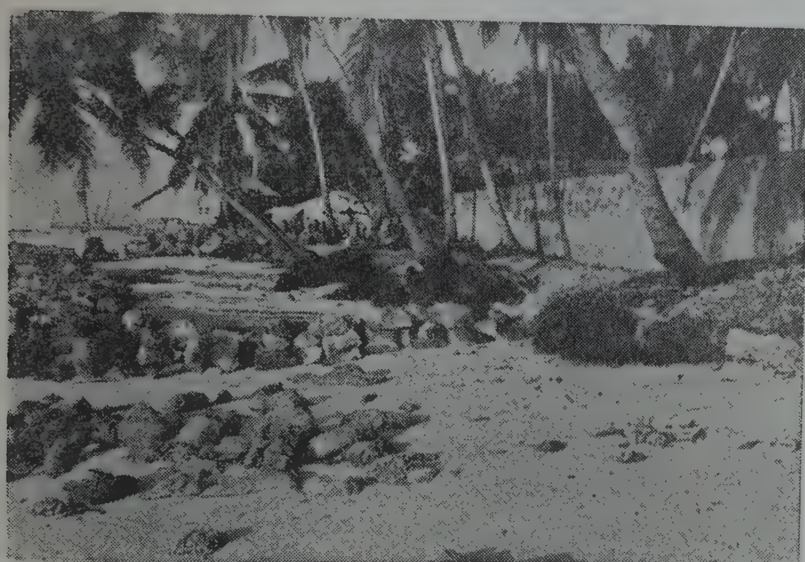


Fig. 2. Sea erosion is a major factor for siltation in the lagoon.

the Indian Ocean reefs, it may be stated that the reefs of Lakshadweep were also built in Tertiary and Quartenery eras on volcanic structures and the present day surface features of the reefs are the results of erosional and depositional consequences of Pleistocene and Holocene sea-level changes (Stoddart, 1973).

The structure of the coral fauna

Composition of the coral fauna: To the date there exists no comprehensive account of the coral fauna of Lakshadweep. Our knowledge of the fauna is based only on Minicoy at the south and Kiltan at the north. A total of 28 genera comprising of 73 species of stony corals are hitherto recorded (Pillai, 1971, 1972) (Table 1). The octocorals are represented by *Heliopora coerulea* which form a very conspicuous element in the inner lagoon reefs throughout Lakshadweep. The gorgonids are not found in shallow waters. The hydrozoans are represented by *Millipora* with three species known. The affinities of the fauna of Minicoy with adjacent Indian Ocean areas were discussed by Pillai (1971a). Both ramose and massive corals dominate. The genus *Acropora* is the richest as is the case with all the Indian Ocean reefs, and form about 25% of the total species known from Minicoy. A notable feature of the coral fauna of Lakshadweep is the absence of foliaceous forms such as *Montipora foliosa* and *Echinopora lamellosa. Montipora* a very common genus in Indian Ocean reefs is rare and only one encrusting species is hitherto recorded. The massive species of corals are mainly those of *Porites lutea* and *P. solida. Diploastrea* was very common till recently in Minicoy though there is a dwindling of this coral at present. Ramose *Porites* is essentially a component of the lagoon both in Kiltan, Minicoy and Kavaratti atolls.

Coral sociology

Based on the major assemblage of dominant genera more or less three distinct coral communities can be defined in the various habitats of reefs and lagoons of Lakshadweep as follows.

Porites *community:* The *Porites* community is dominated by *P. lutea* and *P. solida* and is essentially an inner lagoon reef community. Faviids such as *Favia, Favites, Platygyra* and *Goniastrea* are found mixed with. *Pocillopora* spp. and *Acropora* spp. are also found at the sides and top of large *Porites* colonies.

Acropora *community* The *Acropora* community is predominantly of various species of *Acropora* in the lagoon. Both arborescent and corymbose species thrived in the lagoon till recently. *A. formosa, A. aspera, A. teres, A. corymbosa, A. hyacinthus* and *A. humilis* are the common species. This community forms the most ideal habitat for many reef fishes including important live-baits.

Heliopora *community: Holiopora* forms a very dominant coral both in lagoon reef and open reef flat, especially at the former habitat. Among the *Heliopora* colonies many fungiids and some faviids are found. There is a comparative paucity of reef fishes among the *Heliopora* compared to *Acropora* community.

Coral genera of Lakshadweep

The following is a list of coral genera hithereto recorded from Lakshadweep based on information obained from Minicoy and Kiltan (Table 1). Other islands need further study. It is likely that many more common Indo-Pacific genera may occur in Lakshadweep. A total of 73 species and 28 genera is certainly very low for an area like Lakshadweep, and future investigations are bound to bring forth many more unrecorded species and genera.

Table 1. *Coral species occurring in Minicoy and Kiltan atolls*

Genera	No. of species recorded	
	Minicoy	Kiltan
Scleractinian corlas		
1. *Psammocora*	3	3
2. *Stylophora*	1	1
3. *Pocillopora*	4	5
4. *Acropora*	20	11
5. *Montipora*	1	1
6. *Pavona*	2	2
7. *Cycloseris*	1	1
8. *Fungia*	3	1
9. *Gardineroseris*	1	1
10. *Podabacia*	1	—
11. *Goniopora*	2	—
12. *Porites*	6	4
Porites (Synaraea)	1	—
13. *Plesiastrea*	1	—
14. *Favia*	3	2
15. *Favites*	5	1
16. *Goniastrea*	2	1
17. *Platygyra*	1	1
18. *Leptoria*	1	—
19. *Hydnophora*	1	—
20. *Diploastrea*	1	—
21. *Leptastrea*	3	2
22. *Galaxea*	2	1
23. *Merulina*	1	—
24. *Acanthastrea*	1	—
25. *Symphyllia*	2	—
26. *Lobophyllia*	1	—
27. *Euphyllia*	1	—
28. *Turbinaria*	—	1
Non-scleractinian corals		
1. *Heliopora*	1	1
2. *Millipora*	3	3

Ecological impact on coral reefs

Climate: All islands in the archipelago are subjected to cyclones which may do mechanical damage to coral growth. Both northeast and southwest monsoons bring rains to the islands but the runoff to the reef flat seems to be negligible. There are no fresh water streams. The surface current during the monsoons is a major factor that influences the recruitment of many reef organisms in this area including lobsters (Pillai *et al.*, 1984). Total annual rain-fall range from 1,500 to 1,600 mm.

Primary production: The annual net production in Minicoy lagoon from a reef was estimated to be 3,000 gC/m^2/day (Nair and Pillai, 1972). This is comparable to many reefs in Indo-Pacific that show high rates of production. The Minicoy reefs were also shown to be autotrophic. Future estimations are likely to show a retarding trend due to mass mortality of corals that occurred recently, resulting in a cyclic change of community structure.

Predators: The occurrence of *Acanthaster planci* was recorded both at Kavaratti (Sivadas, 1977) and Minicoy (Murty *et al.*, 1980). These starfishes were

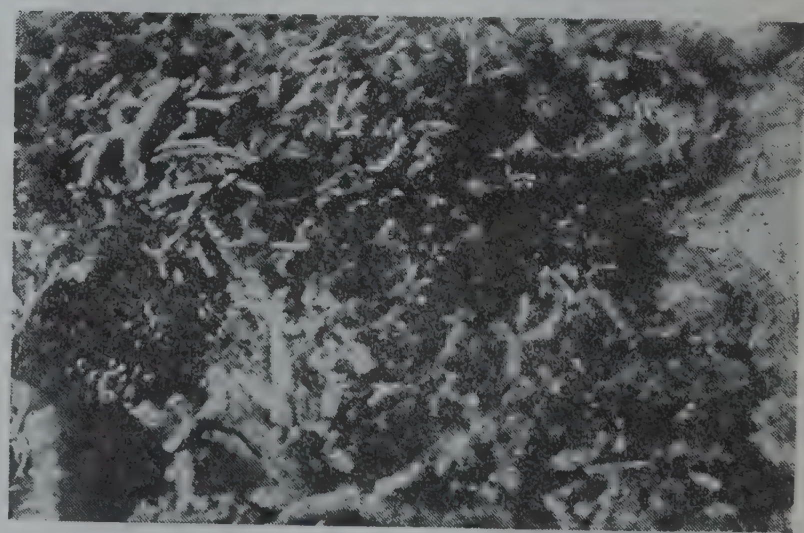


Fig. 3. Dead branches of *Acropora* spp. in lagoon bottom.

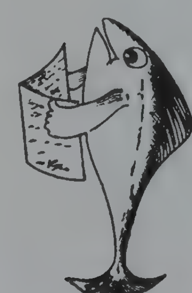
observed to leave white patches on live *acropora* thickets in the lagoon of Minicoy thus causing death to corals. However, they were not found in the lagoon from 1981 probably due to many reasons. They might have played a role in the recent mass mortality of corals seen in the lagoon.

Siltation: The interference from silt smother the corals and kills them. The rate of siltation in the lagoons of Minicoy and other islands would have increased due to sea erosion and disturbances to the lagoon (Pillai, 1983). Further, human interferences have also increased siltation rate in the lagoon which brought out large scale death of corals in all the atolls of Lakshadweep. No detailed study on the rate of siltation in Lakshadweep is available. But it is stated that some of the northern islands have a greater degree of silting and the lagoon are fast getting filled up as in Kiltan.

Human interferences: A comprehensive account of the various aspects of human interference on the atolls of Lakshadweep was presented by the author in an earlier communication (Pillai, 1983). Since human settlement started in these atolls, both their terrestrial and marine habitats were subjected to environmental stress. Removal of corals from the shore and reefs, pitting the ground, removal of surface soil, mining of sand stone as in Kiltan for construction work were all being done. The postindependent developmental activities have further deteriorated the ecosystems. Construction of concrete buildings, cutting of natural vegetation, introduction of exotic plants, introduction of cattle and goats, excessive application of pesticides on agricultural crops are all having adverse impact on the natural ecosystems of the atolls. Blasting of reefs and dredging of lagoon to deepen the boat channels have done irreparable damage to lagoon habitat and has almost killed the entire lagoon coral fauna. Any amount of arguments from any quarters will not justify the unwise decision taken to dredge the channels. Infact, it has not served any purpose except killing all the corals in the lagoon which has effected a drastic dwindling of the resident tuna live-baits.

Resources: The major resources of the Lakshadweep still need further survey and proper assessment. The deep water molluscs, lobsters algae and gorgonids need survey and documentation. A proposal is in vogue in this direction from the Central Marine Fisheries Research Institute to carry out a detailed survey of the northern islands in the immediate future.

Conservation: In view of the deteriorating environmental conditions of this archipelago, effective measures of conservation need to be implemented. The present ban on dredging of reef habitats and collecting of corals should continue. The actions taken to prevent sea erosion by the local Administration should serve a long way in conserving one of our most valuable natural resources.



POTENTIAL RESOURCES OF FISHES OTHER THAN TUNA IN LAKSHADWEEP

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Introduction

The tuna fishery of the Lakshadweep in the south-eastern Arabian Sea is often overemphasised to the extent to create an impression that there is no other exploitable resources of fishes other than tunas, especially the skipjack, *Katsuwonus pelamis*. At present, fishing in an organised manner exists only for tunas in the islands (Jones and Kumaran, 1959). There is a well-established traditional system for the capture of tunas in Minicoy and some other islands with indigenous craft and gear and mechanised boats. The highly productive waters around the islands (numbering twenty seven), the submerged banks and the crevices of coral boulders and reefs offer ideal habitats for a large number of economically important groups of fishes (Jones and Kumaran, 1980) which offers scope for extensive fishing by simple crafts and gears. Most of the other fish resources are now caught either as a by-catch of pole and line tuna fishery or as incidental catches in surface trolling.

The people of Lakshadweep are traditionally dependant on coconut and fish for subsistence for centuries, and avenues for other occupations are limited. Any developmental programme for improving the economy of Lakshadweep and to provide employment to the increasing population has to be mainly oriented towards

Table 1. *Composition of marine fish landings other than tunas and bill-fishes in Lakshadweep during* 1971–'84 (figures *in tonnes*)

Category	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	Average ('82–'84)	Percentage*
Elasmo-branchs	120	157	171	253	325	354	296	198	364	284	211	240	332	287	286	25.6
Catfish	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Half beaks & Belonids	9	19	99	27	29	33	58	144	101	99	113	87	103	62	84	7.5
Flying fish	14	17	42	43	30	41	30	33	16	29	16	25	25	15	22	2.0
Perches	43	83	130	159	186	193	211	163	203	376	315	230	252	205	229	20.5
Goat fishes	8	12	36	32	34	58	29	27	27	27	25	27	32	24	28	2.5
Carangids	20	30	63	61	61	94	65	60	58	80	105	214	147	45	135	12.1
Seer fish	48	51	29	91	66	87	41	41	24	21	50	99	59	59	72	6.4
Barracuda	7	8	11	18	17	20	15	18	11	14	12	10	19	14	14	1.2
Sciaenids	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—
Silver bellies	—	—	—	—	5	—	—	—	—	—	—	—	—	—	—	—
Miscellaneous	134	172	232	279	224	361	281	201	233	206	203	239	237	265	248	22.2
Total (excluding tuna)	403	549	813	963	980	1241	1026	885	1037	1136	1050	1171	1206	976	1118	(24.0)
Tuna	774	514	1020	1254	1932	1291	1166	1875	2794	1760	2236	2966	3303	4313	3527	(76.0)
Grand Total	1177	1063	1833	2217	2912	2532	2192	2760	3831	2896	3286	4137	4509	5289	4645	

* Percentage to the Total (excluding tuna)
Percentage indicated in the brackets refer to percentage to Grand Total

the fishing industry. In this context, the diversification of fishing effort for the exploitation of fishery resources other than tuna and evolving cheaper preservation methods and effective marketing become essential for the futurological development in the fisheries sector of these islands.

Present status of the fishery resources other than tunas

The indigenous fishing craft employed for the capture of other fish resources in the islands vary from five to seven metres in length. In recent years, a few of the dug-out canoes have been fitted with 'Yamaha' outboard engines. Traditional drag nets of varying dimensions and cast nets are in use for the capture of other fishes, mostly from the lagoons. Harpoons are used for capturing sharks, rays and other big fishes from the open sea. 'Chilla' with spikes are used for catching half beaks, belonids and flying fishes. In the open sea, drift netting is carried out on a limited scale by mechanised boats introduced since the early sixties. Occasionally, trolling is done from mechanised boats for catching wahoo, sailfish etc. and long lines are employed for catching sharks and other large fishes. The method of capture is surface trolling with one troll line on either side of the boat. Considerable improvement in the fish landings in the islands have been observed in recent years. However, the increase in the landings of fishes other than tuna consequent on the introduction of mechanised boats is of a lesser magnitude than that of tuna.

The group-wise annual catch, average catch, and the percentage contribution of each group in the landings of other fishes for the years 1971 to 1984 are given in Table-1. The average contribution (average of 1982–'84) of the fishery resources other than tunas to the total fish production of the islands is 24.0%. However, it varies from island to island and is inversely related to the development of pole-and-line fishery for tuna of different islands. The average tuna landings in the islands was 3,527 tonnes and other fishes 1,118 tonnes. The landings of other fish resources excluding tuna was the lowest in 1971 (403 tonnes) and the highest in 1976 (1,241 tonnes).

It could be seen from Table-1 that the commercially important resources other than tunas in the Lakshadweep in the order of abundance are: sharks and rays (25.6%), perches (20.5%), carangids (12.1%), half beaks and belonids (7.5%), seer fishes (6.4%), flying fishes (2%) and goat fishes (2.5%). Devil rays *(Manta birostris)* and sail fish are caught in good numbers by the islanders except in Minicoy. Wahoo, *Acanthocybium solandri* is abundant all round the islands and are fished by trolling lines and harpooning. Sharks, rays, seer fish, snappers, rock cods, rabbit fishes *(Siganus* spp.) and surgeon fishes *(Acanthurus* spp.) are caught in good quantities from submerged banks and reefs when tuna fishing is poor. Flying fishes are caught in good numbers by torch fishing in most of the islands.

Fig. 1. *Abudefduf glaucus* a very common reef-flat fish.

Since fishing effort is concentrated mainly for tuna in most of the islands, the catch of other fishes generally vary according to the fluctuations in the availability of tuna shoals around the islands. When the tuna catch became poor in a particular season, the effort expended for other groups of fishes was increased and consequently the landings of other resources also increased. This indicates that if the effort is diversified, the catches of other resources could be enhanced.

The status of other fishery resources of Minicoy Island

Minicoy Island, where the traditional pole-and line fishery for tunas is in vogue, the fishing effort for other fish resources is mainly during the latter half of the year when the pole and line boats fail to chum tuna shoals. The other fish resources constitute less than 2% of the total fish landing of Minicoy as the fishermen of Minicoy are averse to capture fishes other than tunas. This is not representative of the fishery in the rest of the islands where the proportion of other fishes in the landings is much higher.

The month-wise landings of the various other resources for 1984 and 1985 at Minicoy are given in Tables two and three. The annual average landings of other fishes is about 10.4 tonnes. The major constituents of other resources are wahoo *(Acanthocybium solandri)*, rainbow runner *(Elagatis bipinnulatus)*, carangids, dolphin fish (Coryphaena hippurus), barracudas (*Sphyraena* spp.), perches and sharks. *Acanthocybium solandri* caught mainly by troll lines constitutes the bulk of other fish landings at Minicoy, in both the years (22.8% and 38.7% respectively). The size of *A. solandri* which is a good quality fish ranged from 80–200 cm with a mode at 100 cm. The next most abundant in the landings is *Elagatis bipinnulatus* and *Coryphaena hippurus* which are mostly obtained as by-catch of pole and line fishing. The size of *E. bipinnulatus* in the landings ranged from 40–70 cm. Sharks are obtained in surface trolling and occasionally a by-catch of pole and line fishing for tuna. Eventhough there appears to be a great potential for carangids and perches around Minicoy, no special effort is taken for the exploitation of the resource.

Fig. 2. *Acanthurus triostegus triostegus* the most common herbivorus fish of food value.

From the foregoing, it is evident that the islands have a resource potential for at least four major groups of fishes other than tunas viz., *Acanthocybium solandri,*

Table 2. *Monthly landings of fishes other than tunas and bill-fishes at Minicoy during 1984 (in kg)*

Month	*Acanthocybium solandri*	Carangids	*Elagatis bipinnulatus*	*Coryphaena hippurus*	*Sphyraena* spp.	Perches	Sharks	Total
January	25.0	—	54.5	—	—	—	75.0	154.5
February	10.0	61.0	114.0	—	—	—	50.0	235.0
March	—	—	399.5	—	—	—	1,012.0	1,411.5
April	35.0	—	80.5	—	—	—	270.0	385.5
May	164.0	68.0	—	—	—	307.0	348.0	887.0
June	27.0	82.5	28.0	4.5	—	249.0	—	391.0
July	45.0	2.0	23.0	—	132.5	378.5	20.0	601.0
August	90.0	1,175.5	96.0	11.0	521.5	1,589.5	435.0	3,918.5
September	1,202.0	52.5	31.5	143.0	128.0	55.0	507.0	2,119.0
October	517.0	5.0	273.5	30.0	6.0	—	143.0	974.5
November	471.0	—	817.5	—	—	—	—	1,288.5
December	471.0	2.0	499.0	5.0	4.5	13.0	25.0	1,019.5
Total	3,057.0	1,448.5	2,417.0	193.5	792.5	2,592.0	2,885.0	13,385.5
%	22.8	10.8	18.1	1.4	5.9	19.4	21.6	

Table 3. *Monthly landings of fishes other than tunas and bill-fishes at Minicoy during 1985 (in kg)*

Month	*Acanthocybium solandri*	Carangids	*Elagatis bipinnulatus*	*Corypheena hippurus*	*Sphyraena* spp.	Perches	Sharks	Total
January	248.0	16.0	213.0	19.0	4.0	20.0	—	520.0
February	137.0	5.0	154.0	9.0	2.0	—	410.0	717.0
March	99.0	27.0	212.0	199.0	—	—	190.0	727.0
April	169.0	5.0	235.5	61.0	1.0	—	140.0	611.5
May	29.0	42.0	118.5	6.0	2.0	—	—	197.5
June	20.0	166.0	1.0	12.0	2.0	—	136.0	337.0
July	437.0	74.0	71.5	35.0	21.0	—	297.5	936.0
August	377.0	106.0	41.5	—	1.0	—	20.0	545.5
September	396.0	155.0	45.0	—	—	—	—	596.0
October	371.0	4.0	123.0	74.0	—	—	125	697.0
November	354.0	—	466.5	10.5	12.0	—	—	843.0
December	189.0	29.0	360.5	3.5	—	—	—	582.0
Total	2,826.0	629.0	2,042.0	429.0	45.0	20.0	1,318.5	7,309.5
%	38.7	8.6	27.9	5.9	0.6	0.3	18.0	

carangids, perches and sharks. The other two species i.e., *Elagatis bipinnulatus* and *Coryphaena hippurus* are landed mainly as a by-catch of pole and line fishery.

Strategies for future development

For the rational exploitation of the other fish resources available, attention has to be paid for the balanced development of indigenous and mechanised sector simultaneously.

1) *Development in the small-scale sector*

The small-scale sector remains under developed as the local people are practicing only the age-old methods for fishing to meet the local requirements and this sector

is also not organised. The traditional methods of fishing has not undergone any appreciable change in the islands over the years. Consequently the production of other fishes by traditional fishing operations has not increased significantly when compared to increasing trend in the operations of mechanised boats for tuna fishery.

Diversification of fishing effort, effecting improvements in the existing crafts and gears and providing financial support to develop traditional practices by artisanal fishermen employing indigenous crafts and gears are of prime importance for the development of small-scale sector aimed at the exploitation of resources other than tunas. This is labour intensive and can bring about economic uplift and generate employment to the increasing population.

2) *Large-scale development*

Although the use of mechanised boats for pole and line fishing was introduced two decades ago, there has not been any proportionate increase in the landings of other fish species. The main reason for this is the use of unsophisticated methods of fishing and inadequate marketing facilities. With the realisation of great potentials for increasing the fish landings, it is inevitable to extend the area of fishing operations by adopting improved technology. Sub-surface long lining with modifications suitable for local conditions when introduced will not only increase the exploitation of tunas, but also other resources such as sharks, carangids and perches. The methodologies practiced elsewhere may not be suitable to the conditions prevailing in Lakshadweep and in this context, the prevailing socio-economic level of the people also have to be seriously considered. A survey of the seas around the islands by drift gill netting and long lining have to be carried out to locate and chart productive areas for the different fish resources of economic importance and to evaluate the economics of operations and suitability of different gears.

Post-harvest technology and marketing

Simultaneous with the increased exploitation, facilities for processing and marketing the products have to be provided. At present, tuna is the only fish much sought after by the islanders. The traditionally cured product '*mas min*' is in good demand on the mainland. The other fishes are regarded as second rate by the islanders and hence the problem of disposal of the catch arises while developing other fishery resources. Effective preservation and processing techniques have to be adopted so that the surplus fish is brought to the mainland for marketing.

In order to improve the socio-economic conditions of the fishermen population, it is imperative to implement welfare programmes to provide technical and financial assistance for taking up fishing as an employment by the local population.

As avenues for other occupations are limited, a good percentage of the population remains idle for a substantial part of the year. The problem of unemployment and inadequate returns can be solved by diversification of employment through judicious exploitation of the fisheries resources around the islands. Provision of credit facilities by financial institutions, adoption of suitable preservation techniques and development of marketing facilities in the mainland to fetch higher prices are essential for the all-round development of the fisheries sector.

ANCILLARY LIVING MARINE RESOURCES OF LAKSHADWEEP

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Introduction

Till recently the Lakshadweep archipelago was not investigated upon seriously from a resource point of view. In the latter half of the 19th century attempts have been made by some British naturalists to study the fauna and flora of the Lakshadweep and Maldive Archipelagoes. (Alcock, 1895 - 1900, 1902; Borradaile, 1903; Betts, 1930 and Burton, 1940). Observations of a general nature on fish and fisheries of the islands were subsequently made by Ayyangar (1922), Mathew and Ramachandran (1956) and Balan (1958). However, published information on the marine living resources of the Lakshadweep, other than those of tunas and corals are rather scattered and scanty.

While the major commercially important resources like the corals, tunas and other fish resources of the archipelago are dealt with elsewhere in this volume, here the potential ancillary resources are touched upon.

Sea weeds, crustaceans, molluscs, sponges, echinoderms, reptiles such as turtles, birds etc, are treated here as ancillary resources. There are few others like the beautiful coral reef fishes which are of potential value as an export item for marine aquaria all over the world. Of the above, only the marine algae have been systematically surveyed from a resource assessment angle (Anon, 1979), by the Central Salt and Marine Chemicals Research Institute. Information on the others are based on faunistic observations conducted now and then by different workers.

Algae

Ten islands (Kavaratti, Agatti, Bangaram, Amini, Kadmat, Chetlat, Kiltan, Androth, Kalpeni and Minicoy) were surveyed for the marine algal resources during the 1977-'79 period and estimates of the standing crops were made. Marine algal distribution was generally sparce and heterogenous. All islands except Bangaram supported the growth of marine algae.

The biomass estimates (wet) of the standing crop for all Lakshadweep islands covering an area of 1,334ha was estimated to be within 4,940–10,110 tonnes consisting of 980–2, 100 tonnes of agarophytes, 10–16 tonnes alginophytes and 3,950–7,980 tonnes of others.

The major agarophytes observed were *Gelidiella acerosa, Gracilaria edulis, Gelidium rigidum* and *Gelidiopsis repens*. Alginate resources were meagre represented by *Turbinaria* and *Sargassum*, observed in Kalpeni, Androth and Minicoy. Among the sea weeds categoried as 'others' *Halimeda, Dictyota, Laurencia, Jania, Tolypiocladia, Caulerpa* and *Chondrococcus* constitute more than 75% and are potentially useful sea weeds. Altogether 82 species of sea weeds were collected during the survey, of which only 60 species are found in estimable quantities.

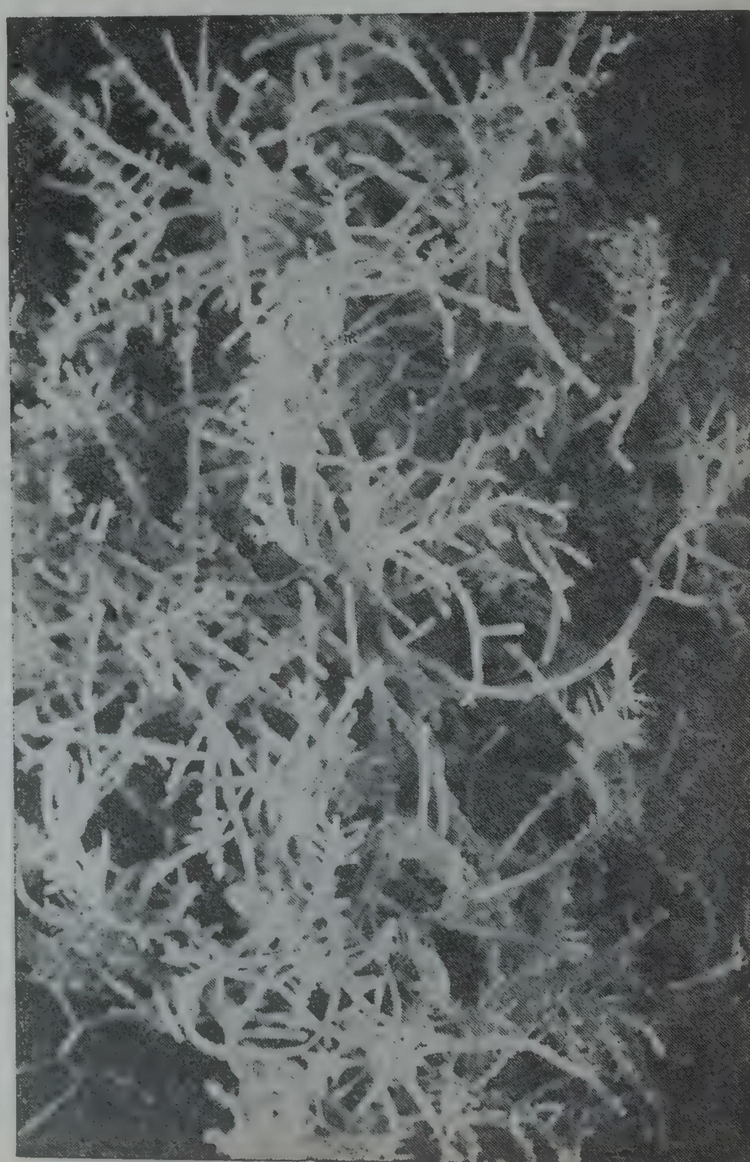

Fig. 1. *Gelidiella acerosa* one of the very common sea weed resource in the Lakshadweep.

Halimedia gracilis was the most abundant form ccurring in lagoon and reef areas. *Gelidiella acerosa* ccurred in all islands except Chetlat and Kiltan.

It is reported that the agarophyte resource with a reponderance of *Gelidiella acerosa* offer an immedia-ly exploitable resource for establishing an *Agar agar* roduction unit. Kalpeni, Kavaratti, Agatti and admat islands have more agarophytes around them. *aulerpa, Dictyota* and *Laurencia* can be used as food different forms.

Regulated harvest of the sea weeds up to 50% vel of the resources is recommended in the report Anon, 1979).

rustacea

The prawns and crabs are not fished in Laksha-weep. The brachyuran crabs and lobsters of Laksha-weep have been studied by Alcock (1895, 1896, 1898, 1899 & 1900) and Borradaile (1903 & 1906). Alcock reported 41 species of crabs and Borradaile 52 species of crabs and two species of lobsters. Sankarankutty (1961) recorded 36 species of crabs from the Lakshadweep out of these 27 were from Minicoy, and the rest from Kavaratti, Aminidivi and Bitra islands. The species include representatives of the familes Portunidae, Grapsidae, Ocypodidae, Xanthidae, Maiedae, Parthenopidae and Calappidae.

Fig. 2. *Panulirus penicillatus*, another lobster found in Lakshadweep.

Fig. 3. *Panulirus homarus*, a common lobster of economic value in the Lakshadweep.

The significant abundance of any particular family is not stated in the above literature, since they were mainly faunistic or taxonomic studies based on one time or intermittent collections by different authors.

Kathirvel (MS) collected 28 species of brachyuran crabs and one species of Panulirid lobster from Kiltan atoll. Meiyappan and Kathirvel (1978) published records of the brachyuran crab *Grapsus albolineatus, Cardiosoma carnifex* and the lobsters *Parribacus antarcticus* and *Panulirus homarus* from Minicoy. Pillai, *et al.* (1985)

recorded *P. versicolor* mostly during November–January period in Minicoy. *P. versicolor* is found to be the most common. The distribution pattern of the lobsters was found to be seasonal, more common on the

Fig. 4. Painted rock lobster *Panulirus versicolor* – a potential reef resource in the Lakshadweep.

reef flats during November–January period. Meiyappan and Kathirvel (1978) found *P. penicillatus* to be the most common lobster in Minicoy in the late seventies while Pillai *et al.* (1984) found *P. versicolor* as the the major lobster at Minicoy. This species is also recorded from Kiltan atoll (Kathirvel, MS).

Mollusca

Smith (1906) listed *Conus, Terebra, Sistrum, Purpura, Nassa, Oliva, Solarium, Trochus* and *Circe* as the common genera widely distributed in Maldives and Lakshadweep. Burton (1940) reported the common occurrence of the giant clam *Tridacna* over the reef of Chetlat Island when he visited the Lakshadweep in 1935. He recorded the shells of *Pterocera* from Bitra. Octopus was recorded from Chetlat and Bitra where they were found in plenty over the reef. In recent times on an average 20 tonnes of these are landed annually in the Lakshadweep islands. *Octopus macropus* and *O. vulgaris* are common in Minicoy, the former forming about 80% of the catch. Both species inhabit crevices in the reef-flat. The islanders use them as food and as bait for fishing.

Appukuttan (1973) observed nine species of coral boring bivalves causing destruction to the fringing reefs of the Islands. They belong to the genera *Lithophaga Botula, Petricola, Gastrochaena* and *Jeuannetia*. Appukuttan and Pillai (MS) observed that the molluscan fauna of Lakshadweep is similar to that of other islands

Fig. 5. *Tridacna* sp. the giant clam that grows to more than half a metre in length.

in the Indian Ocean. They have listed 48 gastropods and 12 bivalves and found the abundance of gastropods in number and species particularly in the littoral and eulittoral reef-flat habitats.

The important families of gastropods observed in Lakshadweep are Patellidae, Trochidae, Neritidae, Littorinidae, Planaxidae, Strombidae, Cassididae, Cypraedae, Muricidae, Buccinidae, Conidae, Vasidae, Terebridae, Ellobidae and Cerethidae. Among the bivalves Arcidae, Mytilidae, Pectinidae, Ostreidae, Chamidae, Tridacnidae, Veneridae, Mactridae, Labitinidae, Tellinidae, Teredinidae and Pholadidae are the most important groups.

Among the gastropods found in these islands, Top shells (Trochidae), Spider conch (Strombidae), Cone shells (Conidae), Cowries (Cypraedae) and Helmet shells (Cassididae) are commercially important. *Trochus radiatus, Lambis* spp., *Arabica arabica, Conus* spp., *Charonia tritonis* and *Cassis cornuta* are some of the beautiful shells available in good quantity in these islands. Giant clams *Tridacna maximum* is found in good numbers in all the islands in the lagoon. Till 1980 good population of the giant clam was observed in the lagoon of Minicoy but at present dead shells of this clam are found in large numbers along with corals. The probable reason for large scale mortality can be siltation due to the dredging operation done in the harbour area. There was also an incidence of aggregation of large spider shells *(Lambis truncata)* numbering 400–500 ranging 20–25 cm in length and weighing 1.15 kg in the lagoon during January, 1984 when water was calm. This species is not found very often in reef flat. It is understood from the older generation of fishermen of the islands that there was good settlement of green mussel *Perna viridis* in Amini Island 20 years back and was used for edible purpose by local people. At present no settlement of mussel is reported from any of the islands. *Cyprea monita* is found in plenty in the inner reef-flat and 1 kg of shell is valued at Rs. 30-40. Usually during low tide large quantities of shells are picked up by women and this has got a good market in the mainland.

Sponges

Thomas (1973, 1979 & MS) mentions 41 species of sponges from Minicoy including typical coral and shell boring species, such as *Spirastrella cuspidifera, S. inconstance* and *Cliona* spp. The common Indian bath sponge *Spongia officianalis* has been observed in Minicoy. Many sponges recorded from Minicoy are rich in Bromine and Iodine.

Echinodermata

Gardiner (1903) observed surface living holothurians very commonly, in Minicoy and mentioned about large numbers of a white variety living in sand. Burton (1940) recorded holothurians of several varieties in every

Fig. 6. *Holothuria atra* – a common sea cucumber on reef-flat and lagoon.

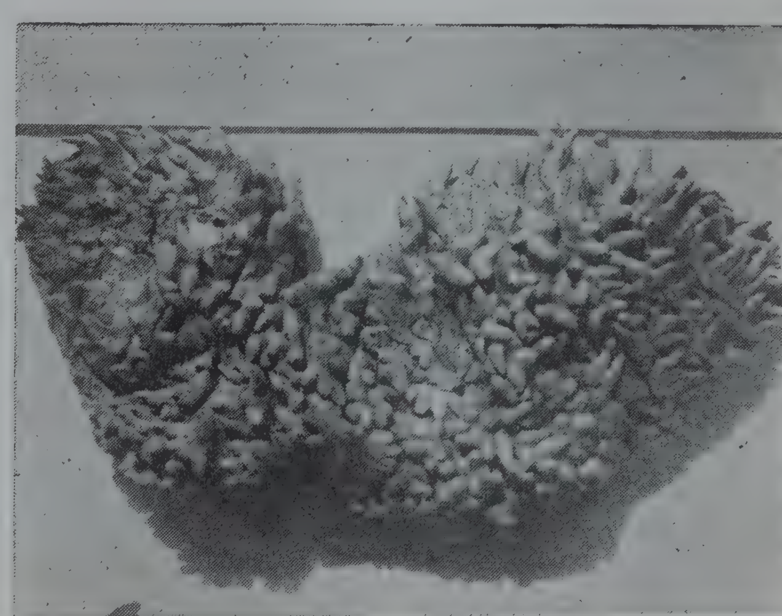

Fig. 7. *Thelenota ananas* – a holothurian used in the preparation of Beche-de-mer, an export product. (Photo courtesy : D. B. James)

pool in Chetlat. *Holothuria atra, H. seabra, Actinopyga mauritiana,* and *A. echinites* are the most abundant species in Minicoy. Ten species of echinoderms were recorded by James (MS) from Kiltan atoll of the northern part of the Lakshadweep. These include the

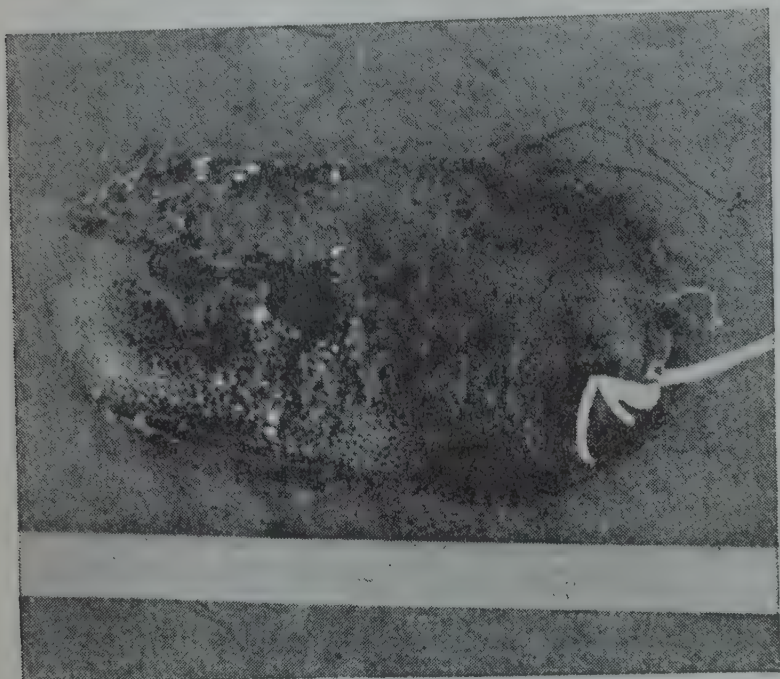

Fig. 8. *Bohadschia marmorata* – another holothurian used in preparation of Beche - de - mer. (Photo courtesy: D. B. James)

holothurians *Stichopus chloronotus, Bohadschia marmorata, Holothuria rigida, H. impatiens, H. pardalis, H. leucospilota* and *Actinopyga mauritiana.* The cake urchin *Clucila novaeguineae* and ophiuroid *Ophiocoma orinaceus* were the other echinoderms collected around Kiltan.

These information point to the possibility for a modest *Beche-de-mer* industry in a suitable location in the Lakshadweep.

Turtles

Bhaskar (1984) reports four species of turtles which occur and nest in Lakshadweep. They are the hawksbill *(Erethmochelys imbricata)*, the olive-ridley *(Lepidochelys olivacea)*, the green turtle *(Chelonia mydas)* and the leather-back *(Dermochelys coriacea)*. The last one is reportedly very rare.

The green turtles nest mainly during the southwest monsoon (June–September) on the Suheli Valiakara, Suheli Cheriakara, Tinnakara, Bangaram and Parali. A feeding and nesting population of green turtles are observed in Minicoy. A few hawks-bills and olive-ridleys also nest on Androth, Kadmat and Agatti islands. Trading in hawks-bill scutes through Mangalore existed in earlier years. Turtle fat especially that of the green, olive-ridley and the leather-back is used by islanders for water proofing the wooden boats.

A cautious approach to exploitation of the turtle population of Lakshadweep archipelago is necessary as their existence here with least human predation serves to conserve them in this niche. Therefore future activities of constructions, agricultural operations etc. along known nesting beaches may be carefully planned.

Birds

Alcock (1902) found the whole sand banks of Pitti island literally covered with the young of two species of terns. The only specific study on the birds of the Lakshadweep islands seems to be that of Betts (1938). Of the 44 species of birds reported by Betts there were several shore and water birds like plovers, terns, sand pipers, shear waters, teals and herons.

Marine ornamental fishes and other marine organisms

Trade in marine ornamental fishes for home aquaria in different parts of the world started some time in the mid sixties. Philippines, Indonesia, Singapore and Sri Lanka are some of the countries exporting marine ornamental fishes. Mostly marine species caught in the wild are used in this trade. Most salt water ornamental fishes come from coral reefs.

Cheap to very expensive ornamental fishes are available. Sri Lanka price for a specimen of the file fish is reportedly 50 US $. (Kvalvas Gnaes, 1982). Varieties such as *Abudefduf, Amphiprion, Apogon, Coris, Balistes, Platax* and several other beautiful coral reef fishes are available in Lakshadweep. Ornamental invertebrate such as sea anemones, crustaceans, echinoderms and sedentary tube worms are also reared in marine aquaria and hence have marketing possibilities.

Limited exploitation of these hitherto untouched resources for capturing a share of the worlds ornamental marine organisms trade is worth attempting.

PROSPECTS OF DEVELOPMENT OF MARINE FISHERIES RESOURCES IN LAKSHADWEEP

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Introduction

The Central Marine Fisheries Research Institute in the past has carried out a number of research programmes in Lakshadweep especially around Minicoy, through its research centre located there. The investigations covered studies on the survey of fauna and flora of the Lakshadweep, the biology and fishery of tunas, the biology and fishery of live-bait fishes, other ancillary resources like sea weeds, sea cucumbers, lobsters and molluscs, oceanographic phenomena affecting the fish resources and coral reef eco-system. However, in recent times, the concentration of efforts was on corals, tunas and live-bait fishes.

A good data base has already been developed by the Institute on various marine resources of the islands and related conservation problems. However, the studies have been mostly confined to the seas around the Minicoy Island. Due to acute limitations of staff, residential facilities, vessel and other infrastructural facilities, the Institute was not in a position to undertake several other important programmes of the region. The Institute has now proposed certain priority projects which will be implemented as soon as the required facilities become available.

In the present paper, the potentialities and the areas where future research and developmental activities need to be directed are briefly discussed.

Tuna resources

Stock assessment studies have shown that there is good potential of tuna resources around the islands (Silas and Pillai, 1982, 1986). Currently, exploitation is in the near shore waters through pole and line fishing. Introduction of larger pole and line boats with storage facilities and simple navigational aids would facilitate the fishermen to move beyond the traditional grounds to scout for tuna shoals and obtain better catches. Apart from pole and line fishing, other operations like gill-netting, surface–trolling and long-lining suited for local conditions could be tried and popularised for tuna fishing which incidentally would help in reducing the pressure on live-bait requirements.

It is now well established that tunas are attracted by floating objects. Trials on fish aggregating devices have been conducted by a number of countries and several methods are now available. In Lakshadweep, a beginning has already been made in the setting up of 'Payao' type of fish aggregating device off Kavaratti Island by the Fisheries Department. The aggregating tunas are caught by the traditional gears. The method with modifications if needed can be extended to the whole region for increasing tuna catches in the small-scale sector.

Live-bait resources

An important component of pole and line fishing is the availability of coral-associated bait fishes. In recent times, acute shortage of live-bait fishes for the tuna fishery has been faced. The Institute, based on the continuous observations which were made over the past years attributed the following reasons for the shortage of live-bait fishes in the Lakshadweep.

Due to heavy exploitation of the live and dead corals from the islands, the bottom of the sea has been greatly disturbed, which resulted in siltation of the reefs and consequent large scale mortality of the live corals. This has also caused some amount of erosion around the island. The periodic dredging of the lagoon also contributed to disturbances of the bottom and consequent siltation killing the live corals. Since several invertebrate and vertebrate organisms are closely associated with the coral reef ecosystem, any damage caused to the coral reef results in damage to the populations of different organisms inhabiting the coral reef. The live-bait fishes form an important component of the eco-system and hence the populations appear to have deserted the disturbed areas.

The second reason for shortage of live-bait is the lack of recruitment of the young ones of these fishes to

the populations. The live-bait fishes of Lakshadweep are broadly classified into resident and non-resident or migratory species. If continuous exploitation of the live–bait takes place without proper recruitment, there would be a decline in the total populations of live–bait fish. The recruitments may also be affected by the meteorological conditions through strong wind and currents, which drive away the eggs and larvae of live-bait fishes to regions other than the conventional lagoon waters.

The third reason in declining the live–bait fish population is the increasing demand of these fish to meet the pole and line fishery for tuna. The tuna fishery a decade or so ago was restricted only to the Minicoy Island. But in recent times, the fishery has expanded to other islands as well, bringing in a catch of about 5,000 tonnes per year. This enlarged fishery naturally required more live–bait and hence exploitation of limited resources of live–bait has led to depletion of stocks.

The catch statistics for tuna and live-bait resources are mainly taken by the Institute from the information available with the local administration. Although the staff of the Administration have been trained by the Institute, comprehensive data on these resources are still wanting to cover effectively all the islands from where tunas are captured. For a proper management of the tuna fishery and steady supply of live-bait fishes for the local tuna fishery, reliable estimates of potential and exploited stocks are necessary. Through critical analyses of data collected systematically, it would be possible to plan ways and means of augmenting the live–bait resources. Therefore, future research programmes of CMFRI would concentrate on estimation of exploited and potential resources separately of tuna and the live-bait. In addition, surveys should be conducted to identify suitable resources of live-bait in the vicinity of the islands and develop methods to transport and maintain the stock for later use in the tuna fishery. Attempts should be made to identify promising species of fishes for artificial propagation and development of stocks to be used as live-bait. Since it is suspected that natural populations of live-bait are available in regions presently not exploited by fishermen, fishing at night through lights could be experimented upon. Attempts will also be made to identify alternate species which could be used as live-baits, for which experiments could be conducted. The possibilities of using artificial bait for catching tuna could also be a part of the over-all programme on live–bait fishes.

Coral conservation

As stated earlier, coral reefs form the habitat of live-bait fishes. At present the stock of these fishes is on a declining trend which inturn affects the pole and line tuna fishery. It is essential to preserve the coral reef eco-system of the islands if the marine resources of the region are to be stabilised (Gopinadha Pillai, 1983, 1985). This programme should involve (i) declaration of a few undisturbed and undamaged areas in the region as a marine park for the protection and preservation of the marine wealth. This would have the advantage of not only preserving the nature but also providing excellent tourist attraction; (ii) conducting experiments to rejuvenate and re-grow the corals by transplanting live and suitable species of corals into regions where they thrived earlier and (iii) adoption of a cautious approach to dredging and blasting operations in the lagoons.

Conservation of the eco-system and the marine resources assumes paramount importance in any future plans for the development of Lakshadweep.

Resources other than tuna

Tuna fishing and production of *'mas min'* are traditional occupations and the islanders have little attraction for other fishes. However, even without much organised efforts, one fourth of the landings in Lakshadweep is accounted for by fishes other than tuna which include important fishes like sharks, perches, carangids, half-beaks, belonids and seer fishes. (Jones and Kumaran, 1980). It may not be possible to exploit these groups of fishes by following the traditional methods like dragnets and castnets. Diversified fishing efforts like drift/gill-netting coupled with improvements in crafts to fish in farther waters would go a long way in tapping these resources. Commercially important crustaceans like lobsters and crabs and molluscs could be developed as minor fisheries, which in addition to enhancing production, will promote exports. Diversification of fishing effort would also help in providing employment and income to the fishermen during the tuna off season.

Several coral reef fishes are considered as excellent ornamental fishes for aquaria in many parts of the world. Many countries import marine ornamental fishes. Studies have shown that there are a number of small but colourful coral reef fishes like butterfly fish, surgeon fish and parrot fish in plenty in Lakshadweep. Collection methods, packaging technologies and transportation

facilities need to be developed so as to tap those resources for export trade.

The lagoons of Lakshadweep are rich in sea-weeds which have good potential for industrial purposes. However, indiscriminate harvesting would adversely affect the stocks. The sea-weed resources will have to be monitored continuously so as to arrive at yield levels which would be sustainable and at the same time do not affect the live-bait and ornamental fisheries.

Limited experiments conducted in Bangaram lagoon for pearl oyster culture showed encouraging results. Further research will be required to study the technical feasibility and economic viability before large-scale programme can be introduced. It may also be worthwhile to undertake investigations on the feasibility of introducing aquaculture programmes for resources suitable to the island conditions.

Storage, product development and marketing

With increased production of tuna and other fishes through developmental efforts in the coming years, preservation, processing and marketing assume great importance. Suitable post-harvest technologies and the needed infrastructure will have to be provided. Even though smoked and cured '*mas min*' from tuna prepared indigenously, is the major product today, methods for improving the quality of '*mas min*' and development of new products from tunas and other fishes will have to be attempted keeping in view the market preferences. Through proper extension methods, utilization of unconventional fishes and their products can be popularised for local markets. But the bulk of the extra production will have to find markets in the main land or in other countries.

Remote sensing

The problems of Lakshadweep are varied and peculiar. For achieving rapid progress, the government has earmarked funds in VII Plan for several development projects with more emphasis on science and technology. The Institute from its side would be able to employ the latest techniques for exploration, research and management. Use of remote sensing for dilineating productive areas of the sea is one such attempt where the Institute has developed expertise in collaboration with Indian Space Research Organisation.

Quantification of biological parameters such as phytoplankton pigments, using bio-optical algorithm is possible through remote sensing techniques. These phytoplankton pigments are the prime synthesizers in the marine food chain and can serve as a link with commercially important fishes through its conversion to other levels in food chain.

By time-series maps from satellites such as IRSS, LANDSAT and NIMBUS-7 it would be possible to estimate the basic productivity in the sea around Lakshadweep so that aggregation of fish schools could be predicted. It would be also possible to evaluate the ecological changes, nature of vegetation, extent of pollution and shore-line changes using modern space technology methods.

Information base

A sound data base is a pre-requisite for planning of research and development of marine fisheries. Data will have to be collected through scientifically planned surveys. Information on physical, chemical, biological, meteorological and environmental parameters in relation to fisheries and data on fish landings, effort expended, economics of operations of various types of fishing units, marketing and socio-economics will have to be continuously gathered and studied. Shore as well as vessel-based programmes covering the entire region will have to be taken up for acquiring the requisite data. It would be possible then to estimate optimum sustainable yield of resources and inter-relationship of fishery dependent and fishery independent factors with fish abundance facilitating fishery forecasting. Such an information base would very much help not only in critically reviewing the progress of the on-going programmes, in identifying bottlenecks and arriving at remedial measures but also for planning objective development programmes for years ahead.

Need for systems approach

Knowledge of the location, density and variations of the marine living resources, developing suitable crafts and gears as means of exploitation, meeting the requirements of man-power including trained personnel, making available the credit needed and providing infrastructure facilities for fish landing, processing, transportation and marketing are some of the important aspects concerned with the development of marine fisheries. Simultaneously the problem of conservation of the environment has to be effectively tackled to prevent any short or long term deliterious effects on the marine resources.

Some of the factors governing the marine sector are complementary but some others may lead to conflicting interests. Keeping in view the prosperity of the islanders, the inter-relationships and interactions of various components will have to be correctly understood. In this context it is desirable to follow a systems approach where the various components are treated as essential parts of the system instead of dealing each problem or a group of problems in isolation at their own merits. In fact, marine fishery itself could be taken as a major component of the total system for the development of the islands. Such an approach would help in bringing to light the complexities of the problem in the correct perspective, in building up proper linkages between the different components and to ensure a fast and balanced growth of the economy of the islands.

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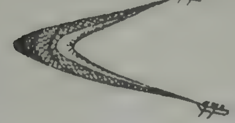

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A. Two species of very common tunas in the Lakshadweep Sea. Above: skipjack *(Katsuwonus pelamis)* and below: yellowfin *(Thunnus albacares)*.
B. The traditional tuna live-bait basket commonly used for keeping live-bait fish in captivity.
C. A collection of recently dead corals *(Acropora* sp.) from Minicoy lagoon.
D. A heap of shells of *Lambis truncata,* an ornamental mollusc, which made an unusual invasion into the Minicoy lagoon in 1984.

MARINE FISHERIES INFORMATION SERVICE

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Abbreviation - *Mar. Fish. Infor. Serv., T & E Ser.,* No. **69**: 1986

CONTENTS

Front cover photo:
Temporary hutment of fishermen at a fish landing centre along the Gujarat coast.

Back cover photo:
A view of the fisheries harbour at Mangrol, Saurashtra, Gujarat

A STUDY ON THE SOCIO-ECONOMIC CONDITIONS OF FISHERMEN IN SOME SELECTED VILLAGES OF MAHARASHTRA AND GUJARAT COASTS

D. B. Sehara, J. P. Karbhari and R. Sathiadhas

Central Marine Fisheries Research Institute, Cochin

troduction

Maharashtra and Gujarat states together have a astal length of about 2,300 km which is about 1/3rd India's coastal line. As many as 500 marine fishing lages with almost same number of marine fish lanng centres are located in this region. About 4 lakhs fishermen population are dependent on fishing, wholly partially, all along this coast. As much as 30% marine fish catch in the country is contributed by ese two states. About 70% of marine fish catch in ujarat and 85% in Maharashtra are contributed by echanised boats which operate mainly trawl-nets, gillts and bag-nets. Bombay duck, sciaenids, pomfret, naeid and non-penaeid prawns, clupeoids, perches, verbar, seerfish, polynemids, ribbonfish, catfish, arks and tunnies form major catch in this region.

The recent technological innovations in marine hing have not shown much impact on the living condins of fishermen and they are still socially and ecomically backward. Economic uplift of the fisheren mainly depends on the growth and development fisheries sector. Hence, location oriented and resoce based developmental schemes are required to be plemented for each region which would help in area anning for socio-economic improvement of fishermen. assess the socio-economic status of fishermen, the ntral Marine Fisheries Research Institute, Cochin, rried out a study on the income, consumption and nployment pattern and the credit facilities available them in some of the fishing villages of Maharashtra d Gujarat.

ork programme

General village information in first stage, were llected from 14 fishing villages of Maharashtra and fishing villages of Gujarat covering three coastal tricts in each state. Subsequently in the second ge, three villages of Maharashtra namely, Ekdara, Alibag Koliwada (both in Raigad District) and Mahim Koliwada (Greater Bombay District) and four villages of Gujarat namely, Umbergaon (Valsad District), Bhimpore (Surat District), Sutrapada Bunder and Mangrol Bunder (both in Junagadh District) were selected for indepth study taking into consideration the size of village, type of craft and gear used, socio-economic status and other factors of fishery (Fig. 1). Information regarding catch, income, craft and gear, indebtedness, employment etc. relating to all the fishermen families in each village were collected by interviewing heads of families through a schedule specially designed for this study. Enumerators were selected from the same

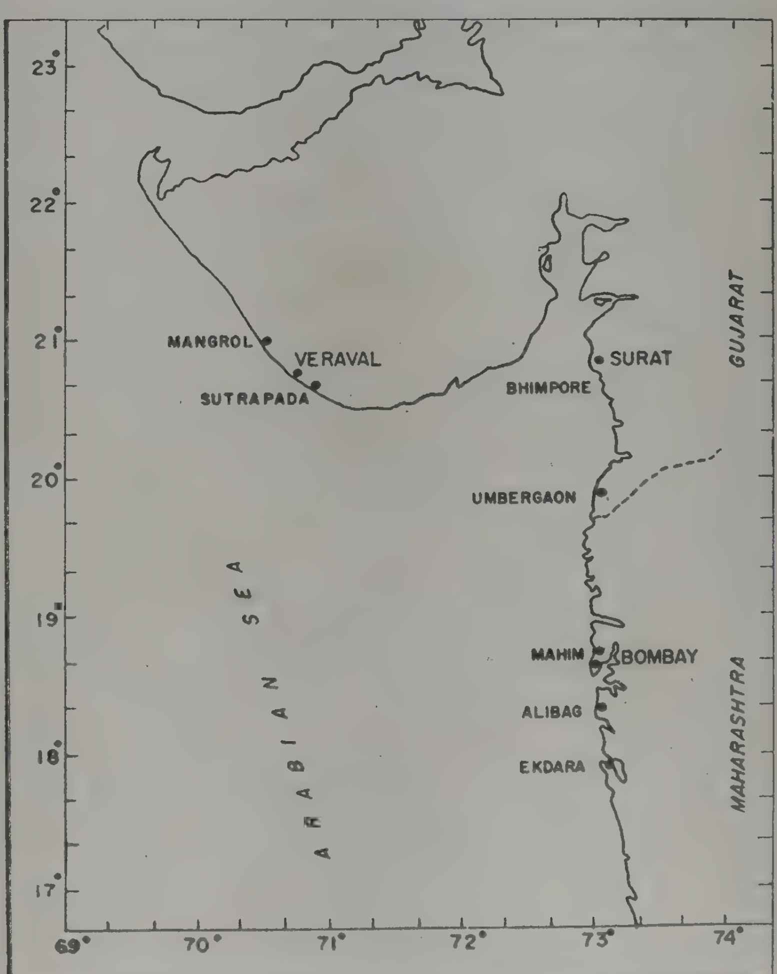

Fig. 1. Villages selected in Maharashtra and Gujarat for the study.

villages and properly trained to ensure accuracy in data collection. Scientific and technical staff of the Institute associated with the project supervised the work of enumerators during the course of data collection.

The definitions of terminologies used in collection and interpretation of data are given below:

1. *Fishermen family:* Family having atleast one member engaged in fishing or fishery allied activities
2. *Family:* Members sharing meals from one kitchen
3. *Children:* All males and females below 12 years of age
4. *Main occupation:* An occupation contributing 50% or more of the income of an individual/family
5. *Subsidiary occupation:* An occupation contributing less than 50% income of an individual/family
6. *Fishery allied activities:* Activities include fish trading, processing/curing, transporting, loading/unloading, net splicing/repairing, boat building/repairing and other activities related to fishery
7. *Catch share:* Share of a family in fish catch obtained from operating owned/partially owned/leased-in boat/gear or from operating others boat/gear
8. *Net fishery income:* Income of a family earned by its members from fishing and fishery allied activities after deducting operational cost
9. *Types of houses:*

   a) *Hut:* A dwelling with mud walls or an enclosure made of *'thattis'* and having thatched roof

   b) *Kutcha house:* A dwelling with brick/stone walls and having thatched roof

   c) *Pucca house:* A dwelling with brick/stone walls and having tiled roof

   d) *Concrete house:* A dwelling with brick/stone walls and having concrete roof

10. *Education:*

    a) *Primary:* 5th standard pass
    b) *Middle:* 8th standard pass
    c) *Higher secondary:* 12th standard pass
    d) *Graduate and above:* Degree holder

11. *OBM boat:* Boat fitted with outboard motor
12. *G. F. C. C. A:* Gujarat Fisheries Central Cooperative Association Ltd.

Details of socio-economic survey

For comparative analysis within the village, all the fishermen families were stratified on the basis of ownership of means of production. One year period starting from July '81 to June '82 was taken as reference period for the study. Results based on the analysis of data collected at the household and village levels are presented below.

1. Ekdara (Maharashtra)

This village is about half-a-km away from Murud town (taluk headquarter) and is mainly inhabited by *'Mahadev Koli'*, a tribal community. There is no *pucca* road inside the village. Infrastructural facilities related to fishery such as cold storage, ice plant and curing yards are available in Murud only. Jetty facility is not available at this centre. A fishermen co-operative society is functioning satisfactorily. It provides fishing implements, and helps fishermen in getting loan from banks and government agencies. The main occupation of the villagers is fishing and fishery related activities and number of carpenters, tailors, labourers and businessmen are limited. About twenty persons are employed in private or public sector. Rice and fish are staple food items in this village. The percentages of hut, *kutcha* and *pucca* houses are 39, 24 and 37 respectively (Fig. 2). There is no concrete house in this village. The percentage of *pucca* houses is more among boat owners.

Fishermen population of this village during 1981–'82 was 1,119 which comprised 328 adult males, 330 adult females and 461 children (Table 1). Average number of persons per family was 8.0. The families with less than 5, 5–9 and 10 or more members were 24%, 62% and 14% respectively. Further analysis showed that percentage of working population was 49.7%. Among the working population, 41.6% was found as active fishermen, 51.6% engaged in fishery

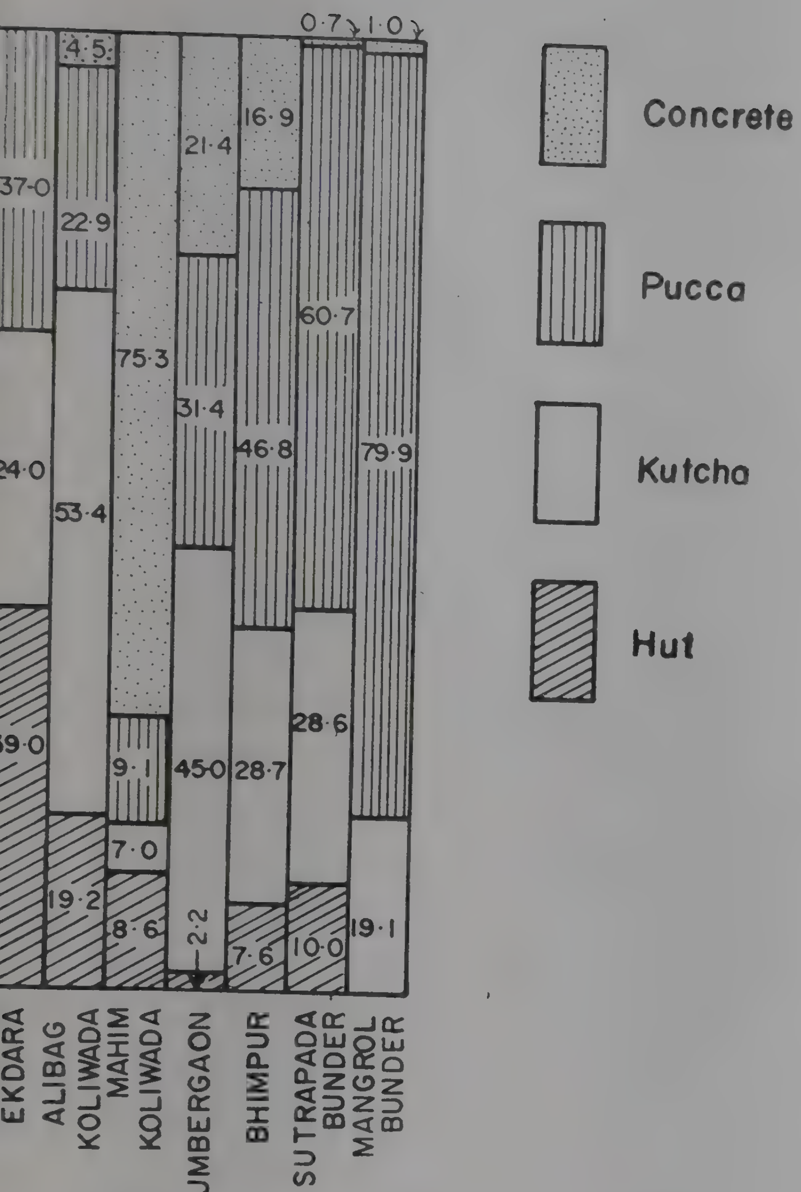

Fig. 2. Type of houses (%).

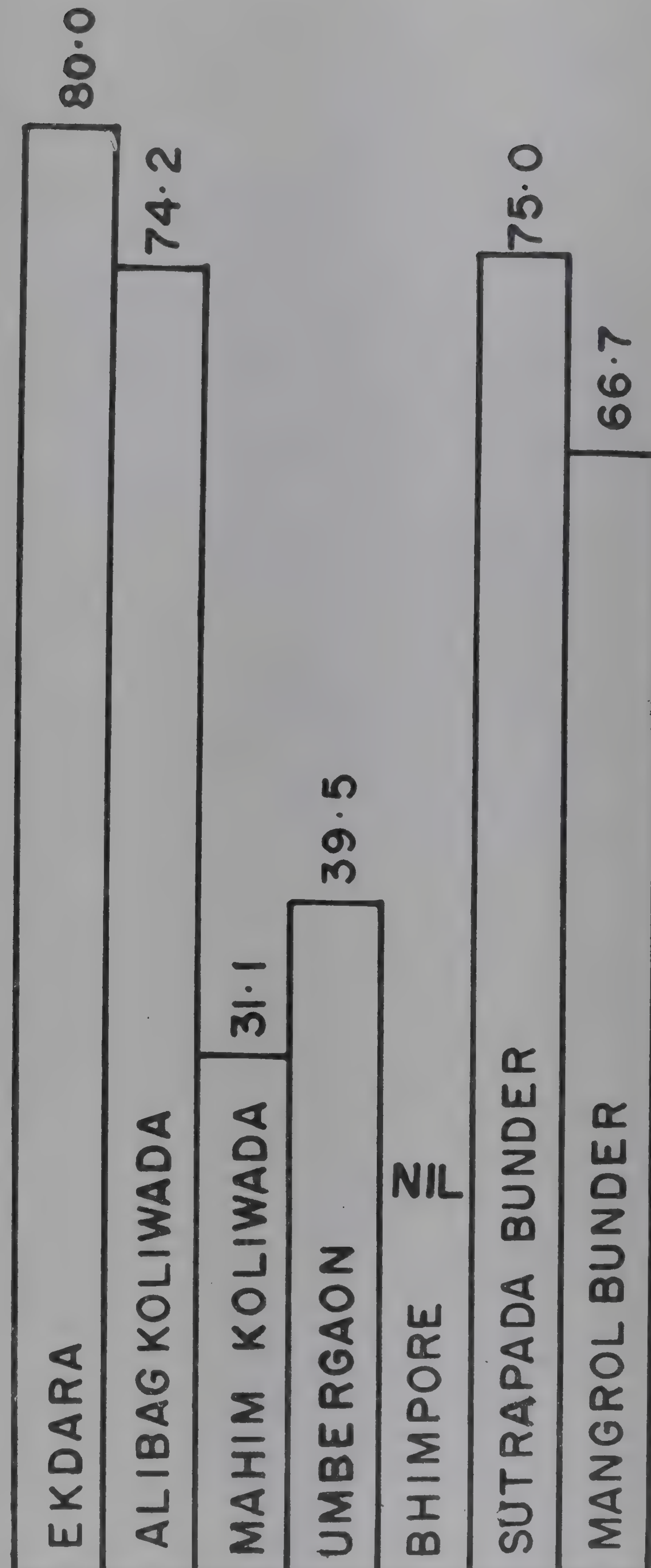

Fig. 3. Membership in fishermen co-operative societies (%).

ied activities and 6.8% employed in non-fishery ivities. Occupation-wise breakup, as given in Table showed that 81% of respondents has fishery as the ly occupation, 13% fishery as main and non-fishery subsidiary occupation and remaining 6% non-hery as main occupation. Literacy among the res-ndents showed that majority was constituted of erates (60%). Persons with primary, middle, higher ondary and graduate and above qualifications were %, 4%, 4% and 1% respectively. About 80% of heads of families were members of fishermen co-erative society in Ekdara (Fig. 3).

About 20 mechanised and 15 non-mechanised boats operating at this centre in addition to few boats ler construction. Mechanised boats are generally ed with Ruston, Kirloskar or Ashok Leyland inboard ines of 2–4 cylinders. Few small boats, locally own as *'tonny'* assist big boats in loading/ oading of catch and transportation of goods. Sur-e and bottom-set gill-nets (locally called *'tarti'* and *'budi'* respectively) and bag-nets, known as *'dol'*, are the main gears operated at this centre. Fishing grounds being rocky, there are frequent cases of engine and net

Table 1. *Fishermen population and occupational status in selected villages of Maharashtra and Gujarat coasts* 1981–'82

Villages	Population				Average family size	Working population (%)	Distribution of working population (%)		
	Males	Females	Children	Total			Active fishermen	Fish. allied activities	Non-fishery occupations
Maharashtra									
Ekdara	328	330	461	1,119	8.0	49.7	41.6	51.6	6.8
Alibag Koliwada	630	636	892	2,158	8.1	56.1	38.0	55.7	6.3
Mahim Koliwada	1,042	1,034	1,388	3,464	6.9	52.8	21.2	58.1	20.7
Gujarat									
Umbergaon	590	583	866	2,039	7.3	54.0	31.7	54.6	13.7
Bhimpore	545	541	693	1,779	7.5	58.0	28.5	51.7	19.8
Sutrapada Bunder	580	579	935	2,094	7.7	46.7	51.5	45.1	3.4
Mangrol Bunder	1,433	1.416	1,814	4,663	7.4	48.4	47.8	51.6	0.6

Table 2. *Education and occupation of heads of the families*

Villages	Education %					Occupation %			
	Primary	Middle	Higher secondary	Graduates & above	Nil	Only fishery	Fishery main others subsidiary	Non–fishery main fishery subsidiary	No. of families
Maharashtra									
Ekdara	31.0	4.0	4.0	1.0	60.0	81.0	13.0	6.0	140
Alibag Koliwada	32.3	6.4	4.9	0.8	55.6	69.6	21.3	9.1	266
Mahim Koliwada	35.2	21.2	12.0	0.6	31.1	32.8	29.3	37.9	503
Total/Average	33.7	14.2	8.7	0.7	42.7	51.0	24.4	24.6	909 (100)
Gujarat									
Umbergaon	29.2	20.1	11.3	1.5	37.9	62.1	20.4	17.5	280
Bhimpore	37.3	22.8	8.0	0.4	31.5	46.5	28.7	24.8	237
Sutrapada Bunder	31.2	6.2	0.8	0.4	61.4	90.5	5.4	4.1	272
Mangrol Bunder	34.1	6.0	1.6	0.2	58.1	91.3	3.7	5.0	633
Total/Average	33.1	11.1	4.9	0.5	50.4	77.9	11.5	10.6	1,422 (100)

damages. During monsoon season there is hardly any fish landing. Dol-net operation is not carried out during neap tides (from 6th to 9th lunar-day), locally known as *'bhang'*. Ice is used only on mechanised boats which go on fishing trips of four to five days. The strength of the crew on mechanised boats ranges from six to nine, whereas on non-mechanised boats it ranges from two to four. Mechanised boats with gill nets operate upto 10 m in the sea. Total number of families (140) were divided into five groups *viz.* families owning/sharing mechanised boats (35), both mechanised and non-mechanised boats (6), non-mechanised boats alone (13), only gears (68) and those engaged in fishery allied activities (18). As can be seen from Figure 4, 37% of families has full ownership and 63% partial ownership of boats. In case of gears, 81% of families has full ownership, 13% partial ownership and 6% leased-in.

Major catch of this centre constitutes pomfret, perches, croakers, penaeid and non-penaeid prawns, silverbar, catfish, sharks, clupeoids and seer fish. The

catch is sold to the private traders through Fishermen Co-operative Society which in turn charges 5% commission from the traders and 1% from the fishermen. Some of the mechanised boats take the catch to Bombay for sale. As shown in Table 3A, the annual fish catch shares of families owning/sharing mechanised boats, both mechanised and non-mechanised boats, non-mechanised boats alone and only gears were found to be 25,067, 29,303, 8,936 and 4,694 kg respectively. Among these categories, the average annual fishing days were found minimum in case of non-mechanised group (198 days) and maximum in case of the group owning only gears (206 days). There was not much variation in fishing days among different categories. The average annual net fishery income per fishermen family was calculated at Rs. 5,313 in this village. Maximum fishery income (Rs. 11,873/annum) was found for the families owing/sharing both mechanised and non-mechanised boats and minimum (Rs. 3,362/annum) for families engaged in fishery allied activities. Analysis of indebtedness showed that for those availed loan (79%), average outstanding loan was Rs. 2,868 per family during the reference year. Families engaged in fishery allied activities availed minimum amount of loan (Rs. 484) among the five categories. Maximum outstanding loan was found for the families owning/sharing both mechanised and non-mechanised boats (Rs. 8,560) followed by those owning/sharing only mechanised boats (Rs. 5,420). Further analysis showed that about 21% of fishermen families did not avail loan from any source (Table 4) and the rest had availed loan from Fishermen Co-operative Society (40.4%), government (10.4%), banks (10.0%) and private agencies (21.8%).

2. Alibag Koliwada (Maharashtra)

This fishing village is located at southwest end of Alibag town and dominated by 'Mahadev Koli,' a tribal community. The village has got electric and water connections. The distance of landing centre from the village is about a km whereas fish market is located inside the village. Fish drying yards are provided by Customs Department on rent/lease of Rs. 10–15 per year to the fishermen. Neither jetty facility nor boat building yard is available at this centre. Ice plant and cold storage facilities are available at about 2 km in the town. Diesel and kerosene oil are provided through Fishermen Co-operative Society. About 10 families have marginal land holding for farming. There are 10 carpenters, one barber and four tailors. Baskets, ropes and mats are made in more than 20% of the houses. Couple of provision shops, hotels and tea stalls are also available in the village. More than 100 persons are employed in government, semi-government and private organisations. Rice and coconut are the major crops grown in this area and rice and fish are main food items of villagers. The analysis of type of houses showed that the percentages of hut, *kutcha, pucca* and concrete houses were 19.2%, 53.4%, 22.9% and 4.5% respectively (Fig. 2).

Fishermen population (2,158) of the village consists of 630 adult males, 636 adult females and 892 children (Table 1). The average size of family was 8.1 in Alibag Koliwada during the reference year. Further analysis of family strength showed that 15.8% of families had less than five members, 52.6% between five and nine and 31.6% had 10 or more members per family. Working population was found to be 56.1%, of which 38% was found as active fishermen, 55.7% engaged in fishery allied activities and 6.3% in non-fishery activities. Of total respondents, 69.6% reported fishery as their only occupation, 21.3% fishery main and non-fishery as subsidiary occupation and 9.1% non-fishery main and fishery as subsidiary occupation. Literacy among the respondents was 32.3% primary, 6.4% middle, 4.9% higher secondary and 0.8% graduates (Table 2). Of the 266 heads of fishermen families interviewed, 74.2% was found members of Fishermen Co-operative Society (Fig. 3).

About 70 mechanised and 20 non-mechanised boats are operating at this centre. Bag-nets, surface and bottom set gill-nets and few trawl-nets are used for fishing. Dol-nets are operated in 3-5 m of water while gill-nets and trawl-nets operated in 6–12 m. Labour for crew is generally arranged from outside the village and contracted for entire fishing season of eight to nine months a year. Annual wage ranges from Rs. 4,000–6,000 per labourer excluding meals, bidi, pan *etc.* Bag-net is the main gear of this centre operated by five to six persons. Total number of fishermen families (266) were divided into five categories *viz.* families owning/sharing mechanised boats (76), both mechanised and non-mechanised boats (11), non-mechanised boats alone (22), only gears (73) and those engaged in fishery allied activities (84). Ownership of means of production showed that 26.2% of boat operating families had full ownership, 69.8% partial ownership and 4.0% leased-in of boats whereas most of the gears (99%) were found either with single family ownership or partial ownership (Fig. 4).

About 70% of catch at this centre comprises non-penaeid prawns (locally called *'Jawla'*) and remaining (30%) includes penaeid prawns, croakers, ribbon fish, cat fish, Indian-cod and clupeoids. Non-penaeid prawns caught is sun dried and sold through Fishermen

Co-operative Society to the private companies located at Bombay, Mahad, Dasgaon, Belgam and Ratnagiri on contract basis. The society works as commission agent between companies and the fishermen, and charges 5% and 3% commission respectively from them. The society issues advances from time to time to fishermen upto 50% of value of the catch sold through it. About 85% of boat/net operating families sells their catch through the society.

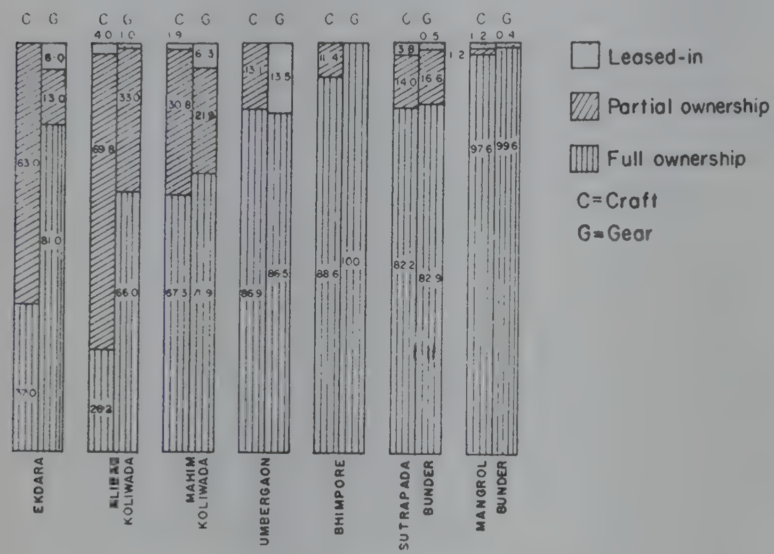

Fig. 4. Ownership of means of production (%).

As shown in Table 3A, the average annual share in fish catch for the families owning/sharing mechanised boats, both mechanised and non-mechanised boats, non-mechanised boats alone and only gears was 37,584, 41,380, 11,990 and 6,255 kg per family for 216, 203, 200 and 192 fishing days respectively per annum. Minimum fish catch was observed in July–September quarter and maximum in October-December quarter for all the categories. On analysis of income per family for different categories it was found that families owning/sharing both mechanised and non-mechanised boats had maximum net fishery income (Rs. 13,016/annum) and those engaged in fishery allied activities had minimum income (Rs. 3,443/annum). The average annual net fishery income per family in Alibag Koliwada was calculated at Rs. 6,118. Among all the categories, maximum outstanding loan was found for the families owning/sharing both mechanised and non-mechanised boats (Rs. 12,182) and minimum for those engaged in fishery allied activities (Rs. 512). Average debt was worked out to be Rs. 4,057 per indebted family. Only 15% of the families did not avail loan during the study year, whereas 45.3% availed loan from Fishermen Co-operative Society, 16.0% from government agencies, 7.0% from banks and 16.7% from private agencies like fish merchants, boat owners, friends, relatives *etc.*

The Fishermen Co-operative Society is helping fishermen in getting loan from government and banks, providing diesel/kersosene and fishing implements and working as agent between fishermen and fish traders.

3. Mahim Koliwada (Maharashtra)

Mahim Koliwada belongs to Greater-Bombay District of Maharashtra and is about 10 km from main city (Bombay). Fish market, bus stand and railway station are within the radius of 2 km from landing centre. The village is electrified and has many facilities of township. Regarding fishery infrastructure, it is observed that no jetty, boat building yard, curing yard or cold storage/freezing plant is available. A Fishermen Co-operative Society is functioning in the village which provides diesel, kerosene oil and fishing implements to the member fishermen at subsidised rate. About 500 persons are employed in public and private sector and the number of self employed persons like doctors, engineers, carpenters and tailors are about 50. Rice and fish are among major items of food. Of the total of 503 fishermen families, 75.3% occupies small concrete houses constructed by Maharashtra Housing Board and allotted to the fishermen whereas the remaining occupies huts (8.6%), *kutcha* (7.0%) and *pucca* (9.1%) houses (Fig. 2).

Total fishermen population was 3,464 including 1,042 adult males, 1,034 adult females and 1,388 children (Table 1). Average number of persons per family was 6.9. Further analysis showed that percentages of families having less than 5, 5–9 and 10 or more members per family were 17.1, 68.6 and 14.3 respectively. Working class constituted about 53% of the population. Among the working population, 21.2% were active fishermen, 58.1% engaged in fishery allied activities and 20.7% in non-fishery activities. As given in Table 2, 32.8% of respondents had fishery as the only occupation, 29.3% fishery main and non-fishery as subsidiary occupation and 37.9% non-fishery main and fishery as subsidiary occupation. About 62% of heads of families engaged in fishery allied activities reported non-fishery as the main occupation whereas 92% of heads of families owning/sharing boats reported fishery as their main occupation. Literacy among the respondents was 35.2% primary, 21.1% middle, 12.0% higher secondary and 0.6% graduates and above. The literacy was comparatively more among the respondents engaged in fishery allied activities and it was justified by the fact that most of them were employed in government, semi-government or private organisations

Table 3a. *Annual fishing days, share in fish catch, income and indebtendness per family in the fishing villages of Maharashtra coast* 1981–'82

Villages & Categories	No. of fishing days	Catch Quantity (kg)	Catch Value (Rs.)	Fishery income (Rs.)	Indebtedness (Rs.)	Families availed loan (%)	No. of families
Ekdara							
Families owning/sharing:							
a) Mechanised boats	203	25,067	52,642	8,588	5,420	77	35
b) Mech. & non-mech. boats	198	29,303	59,363	11,873	8,560	100	6
c) Non-mech. boats	198	8,936	18,996	4,397	3,154	85	13
d) Gears	206	4,694	9,876	3,741	1,228	79	68
Families engaged in fishery allied activities	—	—	—	3,362	484	67	18
Total/Average				5,313	2,768	79	140
Alibag Koliwada							
Families owning/sharing:							
a) Mechanised boats	216	37,584	58,141	10,610	7,844	95	76
b) Mech. & non-mech. boats	203	41,380	65,079	13,016	12,182	91	11
c) Non-mechanised boats	200	11,990	19,424	4,655	3,042	91	22
d) Gears	192	6,255	10,175	3,923	2,141	89	73
Families engaged in fishery allied activities	—	—	—	3,443	512	70	84
Total/Average				6,118	4,057	85	266
Mahim Koliwada							
Families owning/sharing:							
a) Mechanised boats	208	21,086	61,150	9,976	6,630	93	46
b) Mech. & non-mech. boats	208	23,357	66,336	11,667	11,500	100	12
c) Non-mechanised boats	206	7,172	19,082	5,125	2,250	64	28
d) Gears	216	3,403	9,369	4,240	742	45	44
Families engaged in fishery allied activities	—	—	—	3,674	216	33	373
Total/Average				4,572	2,338	43	503

whereas ladies and old persons in the family were engaged in fish trading, net splicing/repairing *etc.* About 31% of the respondents was found members of Fishermen Co-operative Society (Fig. 3). Percentage of the society's membership was comparatively more in case of boat owners (80%).

About 50 mechanised boats including few trawlers and 30 non-mechanised boats operate at this centre. Sufrace and bottom-set gill-net, stake-net, trawl-net and cast-net are commonly used for fishing. Boats varying from 7-12 m in length, 1.5–2.5 m in width and 0.75–1.75 m in depth are fitted with 2–4 cylinder Kirloskar or Ruston engines. In mechanised boats, 5–8 persons go as crew for gill-net operation. Small non-mechanised boats are operated by 2–3 persons. The number of families owning/sharing only mechanised boats, both mechanised and non-mechanised boats, non-mechanised boats alone and only gears were 46, 12, 28 and 44 respectively whereas 373 families were found engaged in fishery allied activities (Table 3A). Ownership of craft and gear (Fig. 4) showed that majority of boats (67.3%) was found with single family ownership followed by partial ownership (30.8%)

Table 3b. *Annual fishing days, share in fish catch, income and indebtedness per family in the fishing villages of Gujarat coast* 1981–'82

Villages & Categories	No. of fishing days	Catch Quantity (kg)	Catch Value (Rs.)	Fishery income (Rs.)	Indebtedness (Rs.)	Families availed loan (%)	No. of families
Umbergaon							
Families owning/sharing:							
a) Mechanised boats	205	24,024	88,802	12,690	9,953	87	68
b) Mech. & non-mech. boats	210	27,631	97,534	15,240	13,655	88	8
c) Non-mech. boats	232	6,960	18,263	7,632	3,429	88	42
d) Gears	219	3,285	8,872	4.862	1,423	66	72
Families engaged in fishery allied activities	—	—	—	3,800	495	83	90
Total/Average				7,134	4,061	80	280
Bhimpore							
Families owning/sharing:							
a) Non-mech. boats	247	11,068	27,027	7,084	1,061	49	35
b) Gears	244	5,114	9,869	4,336	497	45	153
Families engaged in fishery allied activities	—	—	—	3,482	388	71	49
Total/Average				4,565	544	51	237
Sutrapada Bunder							
Families owning/sharing:							
a) OBM boats	214	13,640	35,962	9,204	3,432	83	132
b) Non-mech. boats	218	6,460	17,975	5,038	2,976	75	24
c) Gears	210	2,940	7,702	3,914	1,136	80	25
Families engaged in fishery allied activities				3,378	574	55	91
Total/Average				6,401	2,436	73	272
Mangrol Bunder							
Families owning/sharing:							
a) Trawlers	210	29,108	1,15,020	16,332	13,031	97	150
b) IBM boats	231	21,346	74,002	11,057	9,660	80	5
c) OBM boats	226	12,052	37,436	9,293	4,864	80	95
d) Mech. & non-mech. boats	227	23,972	76,109	12,276	10,784	81	16
e) Non-mech. boats	228	6,961	18,794	5,266	2,975	86	7
f) Gears	217	4,340	11,718	4,621	1,233	86	215
Families engaged in fishery allied activities	—	—	—	3,904	462	47	145
Total/Average				8,184	5,479	79	633

ınd leased-in (1.9%). In case of gears, full ownership, partial ownership and leased-in was 71.9%, 21.9% and 5.2% respectively. Full ownership was more for non-mechanised boats (85.7%) than mechanised boats (61.1%) because of lesser capital investment in former.

Pomfret, seer fish, ghol, *Hilsa*, ribbonfish, silver-bar, catfish, sharks and clupeoids form major catch at his centre. Bulk of the catch is sold in Crauford and Malad (both in Bombay) markets to the private fish traders and the rest in local market generally by fisher-women. A portion of catch is sun dried/salted. Trucks, autorikshaws and headloads are common mode of fish transportation.

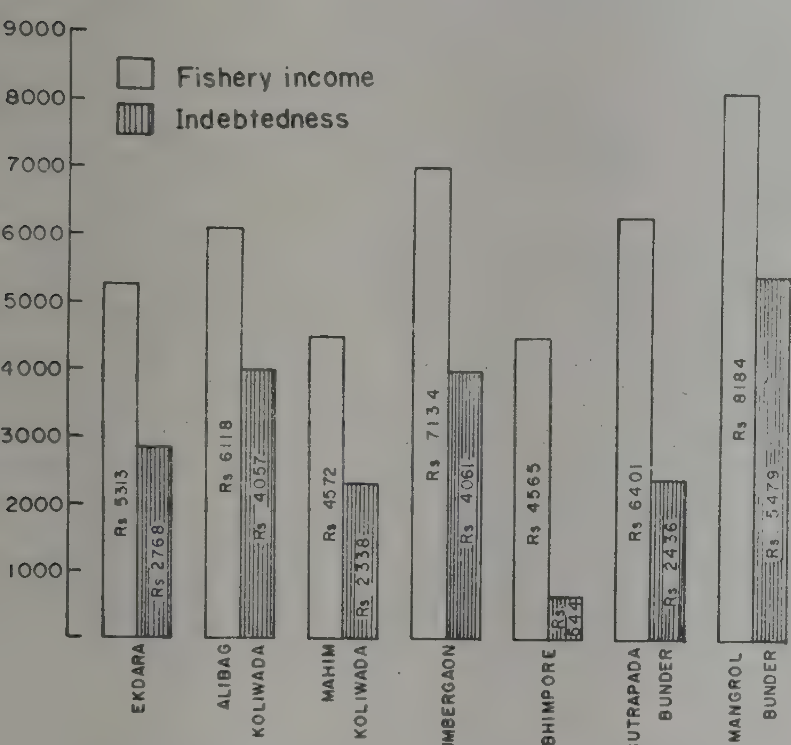

Fig. 5. Fishery income and indebtedness (Rs.).

Table 3A shows that for 208, 208, 206 and 216 annual fishing days, fish catch share for the families owning/sharing only mechanised boats, both mechanised and non-mechanised boats, non-mechanised boats alone and only gears was calculated at 21,086, 23,357, ,172 and 3,403 kg per family respectively. Annual net fishery income varied from Rs. 3,674 for the families engaged in fishery allied activities to Rs. 11,667 for the families owning/sharing both mechanised and non-mechanised boats. The average annual fishery income in Mahim Koliwada was calculated at Rs. 4,572 per family. Like fishery income, maximum outstanding loan of Rs. 11,500 per family was found for the families owning/sharing both mechanised and non-mechanised boats and minimum of Rs. 216 per family for those engaged in fishery allied activities. The outstanding loan per indebted family in Mahim Koliwada was noted as Rs. 2,338 during the study year. Fishermen families availed loan from different agencies like Fishermen Co-operative Society (7.0%), government (5.4%), banks (5.6%) and fish traders/friends/relatives (35.0%) whereas remaining families (47.0%) did not avail any loan.

Fishermen reported increasing pollution in the coastal water due to release of effluents from industrial units which affect the fish catch of this region.

4. Umbergaon (Gujarat)

Fishing is the main occupation of 'Machhi', a Hindu backward community in this village. It is one of the advanced fishing villages of Gujarat based on infrastructure available. It is a medium size fishing village and tahsil headquarter, spreading over an area of about 2 km². The village is electrified and has a small fish market. Water connection and jetty facilities are not available whereas boat building yard, service station, ice plant, cold storage, diesel bunk and kerosene oil agency are available inside the village. Fishermen have a well functioning co-operative society which provides fishing implements and diesel at subsidised rates. Ice factory and boat building yard are working under the management of the society. About 15% of total families (280) have small land holdings for cultivation whereas 20 families have trade and 40 families are engaged in artisanal activities. As many as 300 persons are employed in public and private organisations and 15 self employed as engineers, doctors etc. Rice and fish are the main food items of consumption. As shown in Figure 2, fishermen dwellings constitute huts (2.2%) *kutcha* (45%), *Pucca* (31.4%) and concrete houses (21.4%). No family owning mechanised boat was found to occupy hut.

Total population of fishermen in this village was 2,039 (Table 1) including adult males (590) adult females (583) and children (866). About 20% of families has 10 or more members per family. Families having less than 5 and 5-9 members per family were 15.4% and 65% respectively. Average family size was 7.3 during the reference period. Working population was found to be 54%. Percentage of working population was observed maximum among the families owning/sharing only gears (58.6%) and minimum among those owning/sharing mechanised boats alone (46.6%). Among the working population 31.7% was found as active fishermen, 54.6% engaged in fishery allied activities and 13.7% in non-fishery activities. Occupation analysis further showed that 62.1% of the respondents had

fishery as the only occupation, 20.4% fishery main and non-fishery as subsidiary occupation and 17.5% fishery subsidiary and non-fishery as main occupation (Table 2). Literacy among respondents was 29.2% primary, 20.1% middle, 11.3% higher secondary and 1.5% graduates and above. About 40% of the respondents was members of Fishermen Co-operative Society (Fig. 3). As many as 90% of heads of families under mechanised group were members of the society.

About 75 mechanised boats and 40 non-mechanised boats operate at this centre. Gill-nets, trawl-nets and bag-nets are main gears used for fishing. Big gill-netters go on trips of 15-20 days for 'ghol', 'dara' and shark fishing, whereas trawlers go for 4–6 days mainly for prawn and cephalopod fishing. Generally, from October to January there is bag-net operation (locally known as 'dol') in 3–6 m of water and the same boats are used as gill-netters during other months. Trawlers operating from Bombay base, land at New Ferry Wharf. In monsoon, fishing is carried out in creek with drag-nets, cast-nets and stake-nets. Crew consisting of 6–9 persons operate trawl-nets and gill-nets but stake-net ('gholwa') is operated by 1–2 persons. Wage of crew ranges from Rs. 3,000 to Rs. 5,000 per labourer per annum excluding meals, pan, beedi *etc*. As shown in Table 3b, number of families owning/sharing only mechanised boats, both mechanised and non-mechanised boats, non-mechanised boats alone and only gears were 68, 8, 42 and 72 respectively whereas 90 families were found engaged in fishery allied activities. Figure 4 shows that boats were either with single family ownership (86.9%) or partial ownership (13.1%) and no boat was leased-in/out in this village. Percentage of single family ownership in case of non-mechanised boats was comparatively more. Similarly, there was no leased-in/out of gears and all were either fully owned (86.5%) or partially owned (13.5%). The sharing system of means of production which was prevalent earlier is being discouraged these days. New boats under construction were reported with single family ownership.

Fish catch at this centre mainly comprises prawns, cephalopods, sharks, pomfret, seer fish, bombay duck, threadfin, croakers, polynemids, cat fish, and ribbon fish. Quality fish are sold to private fish traders of Nargol, Maroli and Umbargaon and no catch is sold through Fishermen Co-operative Society. Sun-dried and salted fish are taken to Bombay for sale. A portion of the catch is sold in local retail market and nearby localities by fisherwomen.

As shown in Table 3B, among all the categories, the maximum fishing days were found for non-mechanised group (232 days/annum) and minimum for mechanised group (205 days/annum). Unlike this, share in fish catch per family was maximum for the families owning/sharing both mechanised and non-mechanised boats (27,631 kg/annum) and minimum for those owning/sharing only gears (3,285 kg/annum). Further, net fishery income per family was maximum for the families owning/sharing both mechanised and non-mechanised boats (Rs. 15,240/annum) and minimum for those engaged in fishery allied activities (Rs. 3,800/ annum).

Table 4. *Percentage of the families availed loan from different agencies in selected villages of Maharashtra and Gujarat* 1981–'82

Villages	Percentage of families availed loan from: Fish. Co-op. Society	Government	Bank	Private agencies	Percentage of families not availed loan
Maharashtra					
Ekdara	40.4	10.4	10.0	21.8	21.4
Alibag Koliwada	45.3	16.0	7.0	16.7	15.0
Mahim Koliwada	7.0	5.4	5.6	35.0	47.0
Gujarat					
Umbergaon	4.3	6.0	13.5	56.6	19.6
Bhimpore	—	—	—	51.1	48.9
Sutrapada Bunder	20.6*	—	12.0	40.2	27.2
Mangrol Bunder	—	8.6	10.7	59.4	21.3

*GFCCA provides loan to fishermen in the form of advances through fishermen co-operative society.

Average net fishery income per family was calculated at Rs. 7,134/annum in this village during the reference period. Like income, maximum indebtedness was found for the families owning/sharing both mechanised and non-mechanised boats (Rs. 13,655/family) and minimum for those engaged in fishery allied activities (Rs. 495/family). Average outstanding loan per indebted family was Rs. 4,061 (Table 3B). About 80% of the fishermen families are indebted in this village. Percentages of families who availed loan from Fishermen Co-operative Society, government, banks and private agencies were 4.3, 6.0, 13.5 and 56.6 respectively (Table 4). About 20% of families did not avail loan from any of the agencies.

5. Bhimpore (Gujarat)

Bhimpore is 18 km from Surat and is a backward fishing village. It is situated between Mindhola and Tapi rivers at joining point. The fishing is carried by 'Machhi' / 'Khalasi' who come under economically backward communities in Gujarat according to Bakshi Commission. The village is electrified but water connection is still not provided. A small fish market exists in the village. Jetty facility is available but no boat building yard/service station, curing yard, ice plant, cold storage or petrol/diesel bunk are available. There are 237 fishermen families in the village. About 5% of the families owns small land holdings for farming. About 15 families have provision shops excluding one textile shop. Artisans include tailors (10), carpenters (5) and barbers (5). More than 200 persons from fishermen families are working in public or private owned shipping companies, mills and factories. Rice and fish are main food items of consumption. The percentages of fishermen families residing in huts, *kutcha*, *pucca* and concrete houses are 7.6, 28.7, 46.8 and 16.9 respectively (Fig. 2).

The total fishermen population during the reference year was 1,779 (Table 1) including adult males (545), adult females (541) and children (693). The average size of fishermen family was 7.5. Percentages of families with less than 5, 5–9 and 10 or more members per family are 8, 70 and 22 respectively. Working population is 58%, the highest being 60.6% in case of the families owning/sharing only gears and lowest 56.8% for those engaged in fishery allied activities. Active fishermen formed 28.5% of working population whereas 51.7% engaged in fishery allied activities. About 20% of working population is employed in non-fishery occupations in this village. Among the total of 237 heads of families interviewed, the literacy level was 37.3% (primary), 22.8% (middle), 8.0 % (higher secondary) and 0.4% (graduate and above) (Table 2). A Fishermen Co-operative Society which registered 168 members is disfunct now.

About 30 non-mechanised boats, locally known as 'Sidwala' are in operation at this centre. Drag-net, bag-net, wall-net, stake-net ('gholwa'), gill-net, hooks and line and traps are common gears used for fishing in this village. Fishing by operating small drag-nets in shallow water without boat, locally known as 'Pagadia' fishing, is very common at this centre. Since, no mechanised boat is operating at this centre, the fishermen families (237) were grouped into three categories *viz.* families owning/sharing non-mechanised boats (35), only gears (153) and those engaged in fishery allied activities (49). Results regarding the ownership of means of production revealed that 88.6% of boats was with single family ownership and 11.4% with partial ownership (Fig. 4). No leased-in/out of boat was found in Bhimpore. Similarly, all the gears were found with single family ownership and no gear was with partial ownership or leased-in/out.

At this centre, bombay-duck, prawns, mullet, mud-skipper, cat fish, *Hilsa* and croakers form the major catch. Most of the catch is taken to Surat by bus or autorikshaw and sold to private fish traders. Small portion of catch is sold in local retail market and nearby localities by fisherwomen.

Annual share in fish catch (Table 3B) for families owning/sharing non-mechanised boats and only gears was worked out to be 11,068 kg and 5,114 kg per family for 247 and 244 fishing days respectively. Unlike other centres, there is substantial *Hilsa* landing in monsoon season. Mud-skipper (Gobidae) fishing by means of noose-loop traps locally called 'Phans' or 'Pahi' is a unique method of this centre. Income analysis showed that among the three categories, maximum net fishery income per family was found for the families owning/sharing boats (Rs. 7,084/annum) and minimum for those engaged in fishery allied activities (Rs. 3,482/annum). Average outstanding loan per indebted family was Rs. 544 with maximum of Rs. 1,061 for families owning/sharing boats and minimum of Rs. 388 for those engaged in fishery allied activities. About 51% of total families availed loan from private agencies like money lenders, fish traders, friends, relatives *etc.* whereas 48.9% did not avail any loan (Table 4). Moreover, fishermen are not interested to avail loan either from government or banks for investment on mechanisation because the fish catch was badly affected

due to construction of Ukai dam on Tapi river and increasing pollution in Mindhola river by discharge of effluents from chemical and fertilizer plants and textile mills located in this region.

6. Sutrapada Bunder (Gujarat)

Sutrapada Bunder is about 19 km from Veraval and is connected with coastal highway. The fishing is the occupation of 'Koli Kharwa', a backward Hindu community. All the fishermen have settled near landing centre and the village is known as Sutrapada Bunder which is about 1 km away from main Sutrapada village. About 272 families are engaged in fishing and fishery allied activities. The village is electrified but water connection is not available. It has limited infrastructure facilities. Fish market, boat building yard, curing/processing yards, ice factory, petrol/diesel bunk, cold storage *etc.* are available only at Veraval. Kerosene is supplied through the Fishermen Co-operative Society. This village is covered under World Bank Project for development of fishery infrastructure like link road, jetty, auction hall, water supply, ice factory *etc.* There are five petty shops and four hotels including tea stalls. Besides three weavers and one carpenter, about 20 persons are employed in government, semi-government and private organisations and two persons are self employed. Rice, fish, wheat and *bajra* are main food items of the villagers. The percentages of huts, *kutcha, pucca* and concrete houses are 10.0, 38.6, 50.7 and 0.7 respectively (Fig. 2).

Fishermen population totalled 2,094 (Table 1) comprising 580 adult males, 579 adult females and 935 children. Members per family averaged 7.7. Percentages of families with less than 5, 5–9 and 10 or more members were 21.7, 57 and 21.3 respectively. About 47% was working population. Among the working population, 51.5% was active fishermen, 45.1% engaged in fishery allied activities and 3.4% in non-fishery activities. Of active fishermen, 87.8% was found operating OBM boats and 12.2% non-mechanised boats. Occupation analysis showed that 90.5% of the respondents had fishery as the only occupation, 5.4% fishery main and non-fishery as subsidiary occupation and 4.1% non-fishery main and fishery as subsidiary occupation (Table 2). Majority of respondents was illiterate (61.4%). The respondents with primary, middle higher secondary and graduate qualifications were 31.2% 6.2%, 0.8% and 0.4% respectively. As many as 400 fishermen are members of Fishermen Co-operative Society which provides fishing implements to the fishermen.

About 100 OBM boats, excluding 5 FRP (Ferrocement/fibreglass reinforced plastic) boats and 20 non-machanised boats operate at this centre. Most of the boats are fitted with 6–9 H.P. OBM and run on kerosene oil. Gears used at this centre include surface and bottom-set gill-nets, cast-net, hooks and line and drag-net. Fishermen families were divided into four groups *viz*, families owning/sharing OBM boats (132), non-mechanised boats (24), only gears (25) and those engaged in fishery allied activities (91). There was no IBM (inboard motor) boat in this village. Ownership of means of production showed that 82.2% of boats was with single family ownership, 14.0% partial ownership and 3.8% leased-in (Figure 4). Regarding ownership of gears it was found that 82.9% of gears was with full ownership, 16.6% partial ownership and 0.5% leased-in.

Main catch of this centre constitutes pomfret, seerfish, croakers, *Hilsa* and other clupeoids, catfish, ribbonfish, perches and silverbar. About 22% families sells the fish catch to GFCCA through Fishermen Co-operative Society at the rate fixed/contracted for 15 days to one month by GFCCA with the concurrence of fishermen's representatives. Few families (15–20 boats owners) sell their catch at Veraval to private fish traders and remaining boats sell to private traders in the village. Autorikshaw is the main mode of fish transportation. Most of the catch is sold in fresh form. A small portion of salted and sun dried shark and cat fish is purchased by traders coming from Bombay.

Annual catch share with number of fishing days for different categories is presented in Table 3B. Maximum annual share in fish catch among these categories was found for the families owning/sharing OBM boats (13,640 kg per family) and minimum for those owning/sharing only gears (2,940 kg per family). Annual fishing days were maximum for the families owning non-mechanised boats (218 days) and minimum for those operating only gears (210 days). Further, net fishery income among these categories was also found maximum for the families owning/sharing OBM boats (Rs. 9,204/annum) and minimum for those engaged in fishery allied activities (Rs. 3,378/annum). Average annual fishery income was calculated at Rs. 6,401 per family. Average outstanding loan for the families owning/sharing OBM boats, non-mechanised boats, only gears and those engaged in fishery allied activities was Rs. 3,432, 2,976, 1,136 and 574 respectively. Outstanding loan for indebted families averaged to Rs. 2,436. About 27% of the families did not avail loan from any

source. Percentages of families who availed loan from Fishermen Co-operative Society (from GFCCA advance), banks and private agencies were 20.6, 12.0 and 40.2 respectively (Table 4).

7. Mangrol Bunder (Gujarat)

Mangrol Bunder is an advanced fishing village of Junagadh District. 'Kharwa', a dominating community in the village, is engaged in fishing and fishery allied activities. Mangrol Bunder, which is 3 km from main Mangrol town, is connected by *pucca* road. It has got electric and water connections. Facilities connected with fishery like jetty, boat building yard (under Gujarat Fisheries Development Corporation), service station, curing yards, ice plant, cold storage, petrol/diesel bunk etc. are available within the radius of 3 km from landing centre. Fishermen Co-operative Society provides fishing implements. This village is covered under World Bank Project for providing infrastructure for fishery development. There are 10 retail shops and seven hotels including tea stalls. Most of the artisanal activities are carried out by persons coming from nearby town. A few persons from the village work in government or private organisations. *Bajra,* rice and fish form staple food of the villagers. At Mangrol Bunder, there is no hut and the percentages of *kutcha, pucca* and concrete houses are 19.1, 79.9 and 1.0 respectively (Fig. 2).

Total population (4,663) of this village consists of adult males (1,433), adult females (1,416) and children (1,814). Average family size was 7.4 (Table 1). Families with less than 5, 5–9 and 10 or more members were 22.8%, 67.1% and 10.1% respectively. Working population was 48.4% in this village. Among the working population, 47.8% was active fishermen, 51.6% engaged in fishery allied activities and 0.6% employed in non-fishery occupations. Among the active fishermen, 69.5% was found going on trawlers, 28.5% on OBM boats and 2% on non-mechanised boats. Occupation analysis showed that 91.3% respondents had fishery as the only occupation, 3.7% fishery main and non-fishery as subsidiary occupation and 5.0% non-fishery main and fishery as subsidiary occupation (Table 2). Education level of respondents was of the order of 34.1% (primary), 6.0% (middle) and 1.8% (higher secondary and above). About 67% of the respondents was members of Fishermen Co-operative Society at Mangrol Bunder (Fig. 3).

About 280 boats including 150 trawlers and 95 OBM boats operate at this centre. Trawl-nets and gill-nets are main gears used for fishing. Gill-nets are operated in 8–11m of water whereas trawl-nets operate upto 8 m. In monsoon old gill-nets are used to trap lobsters. Trawlers make fishing trips of 4–6 days and gill-netters 3–4 days, whereas OBM boats go on daily trips. A crew consisting of 6–9 persons operate trawlers and gill-netters whereas OBM boats are operated by 3–4 persons. Most of the gill-netters and trawlers are 40 footers fitted with 4–6 cylinder Ruston or Ashok Leyland engines. Crew members are contracted for fishing season of 8–9 months a year and wage ranges from Rs. 3,000–4,000 per labourer, excluding personal expenditure. Number of families owning/sharing trawlers, IBM boats, OBM boats, both mechanised and non-mechanised boats, non-mechanised boats alone and only gears were 150, 5, 95, 16, 7 and 215 respectively whereas number of families engaged in fishery allied activities was 145. Ownership of means of production showed that 97.6% of boats was with single family ownership and 1.2% each with partial ownership and leased-in/out (Fig. 4). Almost all the gears (99.6%) were found with single family ownership.

Catch at Mangrol centre comprises pomfret, croakers, cephalopods, *Hilsa* and other clupeoids, seer fish, shark, catfish, silverbar, prawns, lobster and sciaenids. Most of the catch is sold to private fish traders. Small portion of catch is sold in retail market by fisherwomen. Head load and autorikshaw are main mode of fish transportation.

Catch particulars (Table 3B) showed that among the six categories, highest share in annual fish catch per family was observed for the families owning/sharing trawlers (29,108 kg) for 210 fishing days followed by those owning/sharing both mechanised and non-mechanised boats (23,972 kg) for 227 fishing days. Quantity of catch share per family was observed minimum for the families owning/sharing only gears (4,340 kgs/annum) for 217 annual fishing days. Annual fishing days ranged from 210 to 231 among different categories. Net fishery income was found maximum for the families owning/sharing trawlers (Rs. 16,332/annum) followed by those owning/sharing both mechanised and non-mechanised boats (Rs. 12,276/annum). Among all the categories, minimum fishery income was observed for the families engaged in fishery allied activities (Rs. 3,904/annum). The average income per family at Mangrol Bunder was calculated at Rs. 8,184/annum. Income and indebtedness have got similar pattern for fishermen families under different categories. Maximum outstanding loan was found for the families

Fig. 6. Unloading of catch at Navabunder.

Fig. 7. Sorting out of catch at Navabunder.

Fig. 8. Net repairing at Sutrapada.

Fig. 9. Net repairing at Madh. In the background are the fish drying stands.

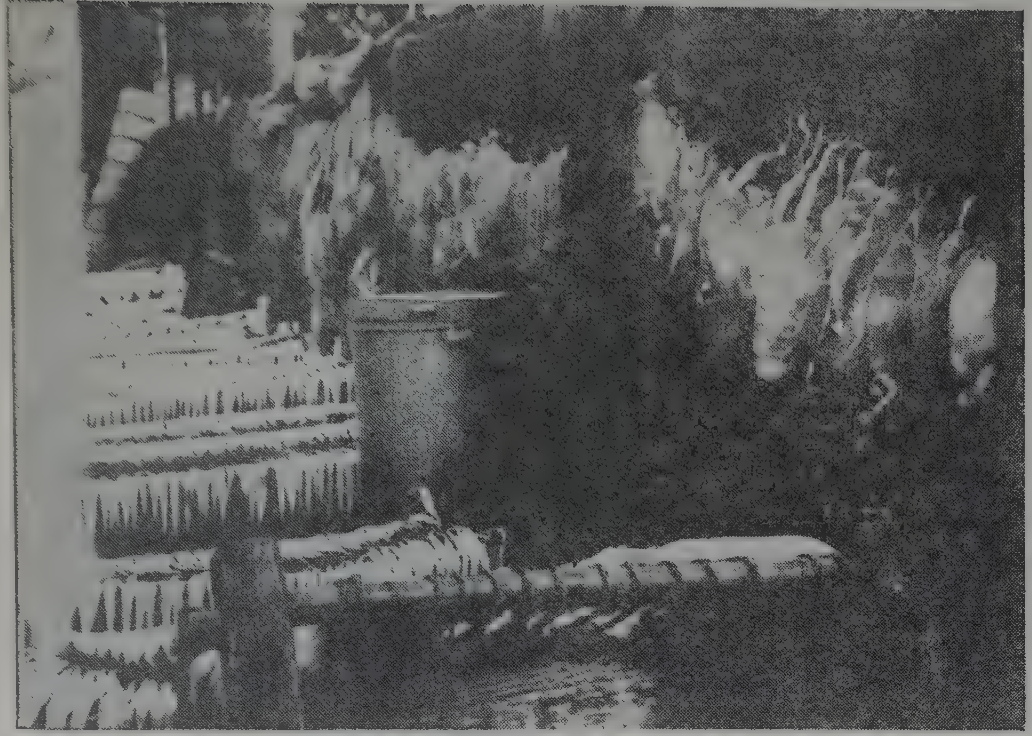
Fig. 10. Fish maws of cat fish, wam, ghol etc. are being sundried on the raised platform at umbergaon.

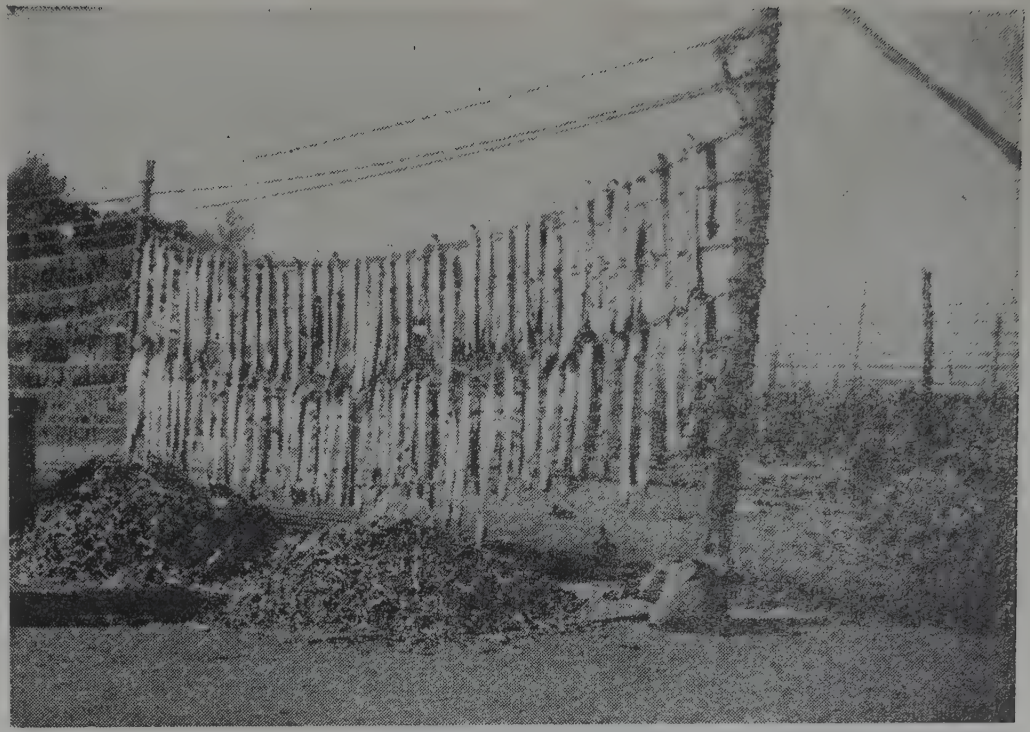
Fig. 11. Sundrying of ribbon fish at Navabunder.


Fig. 12. Fishermen arranging dry fish in bundles at Navabunder.


Fig. 13. Sorting of dry fish at Navabunder.

Fig. 14. Fisherwomen with dry fish bundles on head are going to fetch water. A scene at Navabunder.

Fig. 15. Fisherwomen with fish baskets on head enter the state transport bus at Bhimpore.

Fig. 16. Dry fish ready for disposal at Navabunder.

Fig. 17. Temporary dwelling of labourers near fish drying yards at Navabunder.

owning/sharing trawlers (Rs. 13,031) and minimum for those engaged in fishery allied activities (Rs. 462). The average debt was worked out to be Rs. 5,479 per indebted family. As shown in Table 4, about 21% of families did not avail loan whereas majority availed loan from private agencies (59.4%). The percentages of families who availed loan from banks and government were 10.7% and 8.6% respectively. Fishermen Co-operative Society does not provide loan but helps fishermen in getting loan from government and banks.

Comparison within the state and between the states

Maharashtra villages: Looking at the general condition of the villages and the fishery infrastructure available, Alibag Koliwada ranks first among the selected villages of Maharashtra. Family size is comparatively smaller in Mahim Koliwada. Percentage of working population is highest in Alibag Koliwada whereas percentage of those employed in non-fishery occupations and literacy level is highest in Mahim Koliwada. Dependence on fishing, as main occupation, is found more in Ekdara. Mechanised fishing is mroe prevalent at Alibag Koliwada than other centres which is specialised in seining for non-penaeid prawns *(Jawla)* by bagnet ('dol'). Non-penaeid prawns in bag-net and silverbar in gill-net at Ekdara centre and pomfret and seer fish by gill-net in Mahim Koliwada are among the important catches. Not much difference was observed in ownership status of means of production in these villages. Maximum variation in annual fishing days is observed among different categories in Alibag Koliwada. Fish catch and income of families under different categories are also higher in Alibag Koliwada. The average indebtedness as well as percentage of indebted families are comparatively low in Mahim Koliwada. Percentage of families availing loan from fishermen co-operative societies is the highest in Alibag Koliwada whereas percentage of those availed loan from private agencies is more in Mahim Koliwada.

Gujarat villages: Based on the mechanisation level and fishery infrastructure available, Umbergaon and Mangrol Bunder are categorised as advanced, Sutrapada Bunder as medium and Bhimpore as backward fishing villages. There is hardly any difference in family size among these villages. Percentage of workers in the total population is the highest in Bhimpore and lowest in Sutrapada Bunder whereas percentage of population employed in non-fishery occupations is the lowest in Mangrol Bunder and the highest in Bhimpore. Percentage of active fishermen in working population is the highest in Sutrapada Bunder followed by Mangrol Bunder and the lowest in Bhimpore. Highest level of literacy is observed in Bhimpore followed by Umbergaon and lowest in Sutrapada Bunder. Highest dependence on fishery is noted in Mangrol Bunder and Sutrapada Bunder and lowest in Bhimpore. Mangrol Bunder has several mechanised fiishing boats whereas Bhimpore has no mechanised boat. Main craft at Sutrapada Bunder is OBM boat operating gill-nets. In Umbergaon, gill-nets, trawl-nets and bag-nets are main gears used for fishing. Prawn, bombay duck, pomfret and shark are important catch components at Umbergaon centre. Pomfret and seer fish at Sutrapada Bunder; prawn, seer fish and pomfret at Mangrol and bombay duck and *Hilsa* at Bhimpore form major catch in general. The ownership of means of production shows almost similar trend in all the selected villages of Gujarat. Number of annual fishing days on mechanised boats are comparatively more at Mangrol Bunder. For non-mechanised boats, fishing days are maximum in Bhimpore because there is substantial landing of *Hilsa* in monsoon season. In Umbergaon, bag-net ('dol') is generally operated during October–January and the same boats are used as gill-netters in rest of the fishing season. Between Mangrol Bunder and Sutrapada Bunder, no significant variation is observed in fish catch and income for the families owning/sharing OBM boats. Among the four selected villages, the highest income is found for the families owning/sharing trawlers in Mangrol Bunder followed by those operating both mechanised and non-mechanised boats at Umbergaon. The weighted average fishery income and indebtedness are found highest in Mangrol Bunder and lowest in Bhimpore. Percentage of families availing loan is comparatively more in Umbergaon. Among all the four villages, percentage of families availing loan through fishermen co-operative societies is the highest in Sutrapada Bunder. Majority of the families in Mangrol Bunder and Umbergaon are getting loan from private agencies.

Maharashtra vs Gujarat villages

Socio-economic conditions of Gujarat fishermen are comparatively better than those of Maharashtra. Fishing is mostly carried out by tribal communities in Maharashtra whereas in Gujarat it is an occupation of 'Kharwa'/'Machhi' communities which come under OBC. No significant difference between the states, is observed regarding family size, literacy and dependence on fishing. Standard of fishermen's dwellings in Gujarat is better than Maharashtra. Contrary to

this, functioning and coverage of activities of fishermen co-operative societies in Maharashtra is better than Gujarat in general. There is not much difference in the level of mechanisation in the villages of both the states. There is no mechanised boat in Bhimpore and no IBM (inboard motor) boat in Sutrapada Bunder. Further, it is observed that OBM boats are more popular in Gujarat. There is similarity in trawl-net and gill-net operations but method of bag-net ('dol') operation differs in both the states. Owing to the availability of fish resources the non-penaeid prawns in Maharashtra and bombay-duck in Gujarat are the mainstay of bagnet ('dol') catches. Single family ownership of means of production is more in Gujarat than Maharashtra. Category-wise annual fishery income and fishing days in the villages of Gujarat is more than those of Maharashtra. Indebtedness pattern in both the states shows that heavier the investment in means of production, more the amount of loan availed. Except Mahim Koliwada in Maharashtra and Bhimpore in Gujarat where number of indebted families and amount of out-standing loan are comparatively low, all other villages have majority of families (73–85 per cent) under debt. Further, percentage of families availing loan from fishermen co-operative societies is comparatively more in the villages of Maharashtra and those availing loan from private agencies (mainly fish traders) is more in Gujarat.

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TRENDS IN THE YIELD OF EXPLOITED SCIAENID FISHERY RESOURCES ALONG THE INDIAN COASTS*

Introduction

The fishes of the family Sciaenidae collectively called sciaenids and populalry known as croakers or jew fishes constitute one of the commercially important ground fishes contributing to a sizeable share in the marine fish landings of India. Thirty species of the family Sciaenidae under 14 genera have been reported from the Indian seas. Though some species like the 'ghol' *Protonibea diacanthus, Otolithoides biauritus* etc. attain 100–120 cm in length, majority of them are in the length range of 20–35 cm or even less.

The initial attempts to discuss briefly about the catch trends of sciaenids along the Indian coasts during the periods, 1950–'62 and 1956–'65 were made by Nair and Banerji (1966) and Rao (1975) respectively. Subsequent accounts by Bensam (1973), Dharmaraja and Philipose (1975) and Rao (1976) pertained mainly to the east coast of India.

In the present account a descriptive analysis is made on the recent trends in the yield of exploited sciaenid fishery resources along the coasts of India during the period, 1966–'84. The all–India statewise catch trends in the order of abundance during the period, 1966–'82 are summarised below.

All-India sciaenid landings

The total all-India sciaenid landings fluctuated from 26,580 tonnes in 1967 to 1,14,533 tonnes in 1975 with an average of 72,202 tonnes (Table 1). The percentage of sciaenid catch to total catch also varied from 2.98 in 1967 to 8.07 in 1975 (Fig. 1A).

Statewise landings of sciaenids

Gujarat

This state ranked first in the sciaenid landings among the maritime states of India with an estimated average

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catch of 22,342 tonnes during the 19 year period from 1966 to 1984, the state's average catch being about 31% of the total all—India average catch. The maximum catch of 45,781 tonnes was recorded in 1975. Though a lesser catch trend was noticed during 1967–'72 period, the subsequent years witnessed higher catches (Table 1). The percentage contribution of sciaenids in relation to total landings in the state indicated a maximum of about 33% in 1973 (Fig. 1B). The increased catch obtained during 1973–'84 period enabled the state to achieve the first place in the sciaenid landings of the country.

The census conducted by CMFRI in 1980 (*Mar. Fish. Infor. Serv., T & E Ser., No.* **30,** 1981) indicates that there are 1,209 trawlers, 1,547 gill-netters and 650 'dol' netters in Gujarat which land appreciable quantities of sciaenids.

Maharashtra

With an estimated average catch of 15,098 tonnes during the period and conrtibuting to about 7% of the state's fish production, Maharashtra occupies second place in the sciaenid landings (21%). The production trends indicate higher catches during 1973–'84 period with a maximum of 21,366 tonnes recorded in 1979 (Table 1).

The percentage contribution of sciaenids to the total catch fluctuated between 5% in 1972 and 9% in 1974 (Fig. 1C). Along the Bombay–Sourashtra coast sciaenids constitute 25.38% in the commercial catches. This indicates the role of mechanised trawlers in enhancing the landings of sciaenids. According to a recent study 87% of the marine fish catch in this state is landed by mechanised boats which bring substantial quantities of sciaenids.

Kerala

Kerala occupies the fifth place (9.9%) among the maritime states in the catch of sciaenids at all–India level with an estimated average landing of 7,146 tonnes (Table 1). The landings during the period 1966–'84 showed a highly fluctuating trend with a maximum of 16,811 tonnes in 1975 and a minimum of

Table 1. *Statewise landings of sciaenids in India during* 1966–'84 *(in tonnes)*

Year	West Bengal & Orissa	Andhra Pradesh	Tamil-nadu	Pondi-cherry	Kerala	Karna-taka	Goa	Maha-rashtra	Gujarat	Total
1966	440	3,144	5,679	810	4,921	1,508	131	7,856	11,543	36,032
1967	496	3,232	8,414	498	4,310	492	146	7,581	1,411	26,580
1968	1,795	2,557	9,836	709	3,630	821	320	7,141	1,496	28,305
1969	1,274	6,874	8,586	895	3,195	1,187	86	10,733	2,211	35,041
1970	2,617	4,091	10,045	481	5,792	1,885	97	12,906	3,989	41,903
1971	2,727	5,954	5,495	391	4,145	1,313	106	13,339	3,443	36,903
1972	2,479	7,277	6,221	546	6,137	2,114	280	11,299	3,806	40,159
1973	1,323	7,576	10,607	626	11,723	1,013	171	14,319	40,324	87,682
1974	1,671	12,358	9,943	250	9,220	3,208	883	17,453	24,275	79,261
1975	4,474	11,682	10,096	212	16,811	1,853	3,048	20,576	45,781	1,14,533
1976	4,399	10,891	10,562	434	6,955	3,216	2,640	19,781	28,698	87,576
1977	1,131	10,182	13,756	258	11,965	2,762	2,779	17,086	39,968	99,887
1978	6,970	5,597	14,239	374	13,045	1,728	3,256	17,202	33,968	96,379
1979	6,266	8,825	18,948	306	5,237	2,348	1,492	21,366	28,230	93,018
1980	3,222	9,496	19,547	320	6,164	3,500	1,530	13,956	31,625	89,360
1981	2,403	7,046	13,140	330	3,145	2,295	1,610	17,475	35,242	82,686
1982	4,785	8,779	22,029	561	3,581	2,326	2,298	15,926	26,962	87,247
1983	14,123	11,554	13,143	454	6,112	4,067	2,697	18,278	29,647	1,00,075
1984	19,885	8,047	12,707	741	9,686	2,005	1,677	22,588	31,887	1,09,223
Average	4,341	7,640	11,736	484	7,146	2,086	1,329	15,098	22,342	72,202
Percentage	6.01	10.58	16.26	0.67	9.90	2.89	1.84	20.91	30.94	

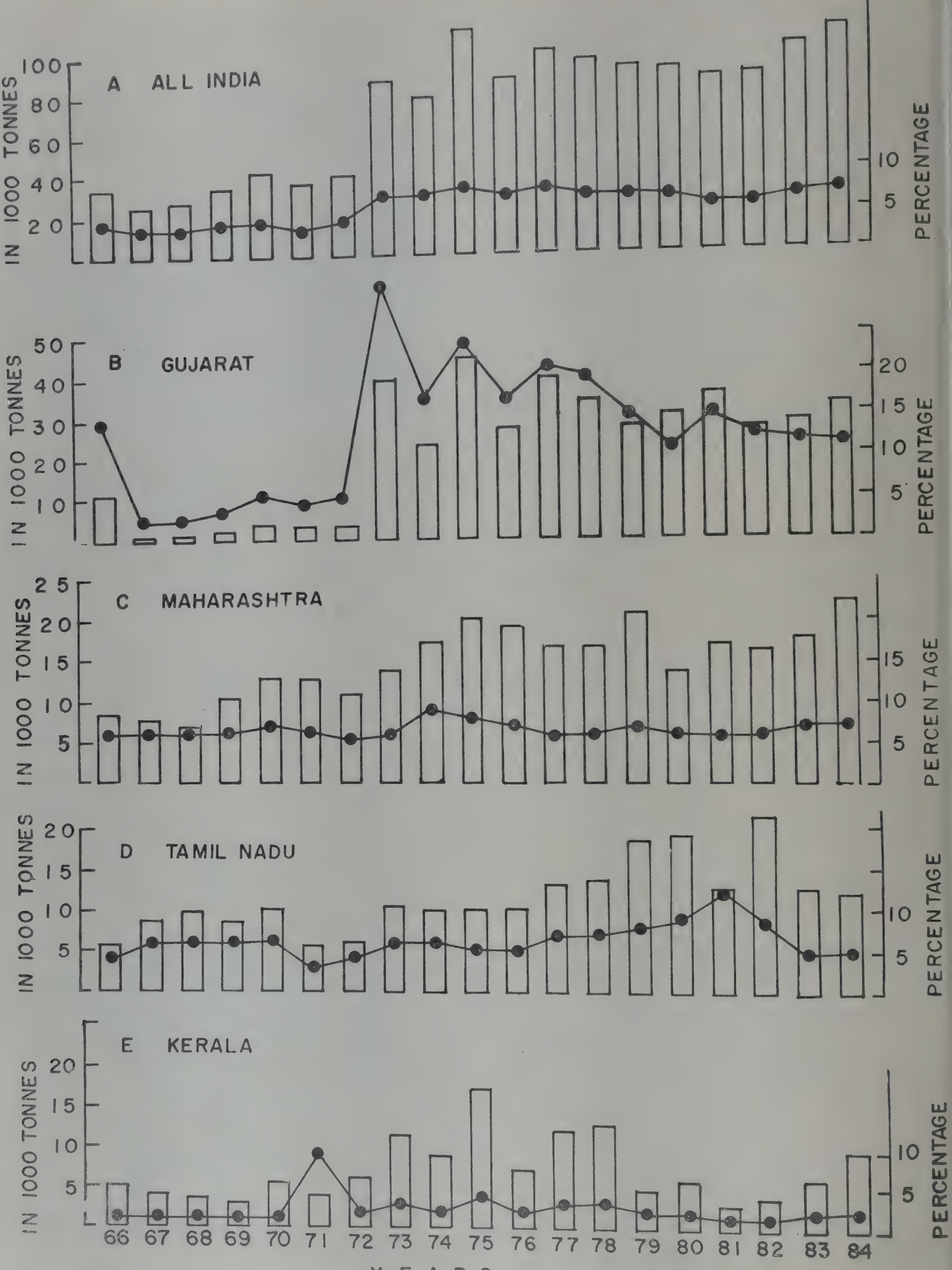

Fig. 1. Landings of sciaenids in the states of Gujarat, Maharashtra, Tamilnadu, Kerala and all-India and the percentage contribution to total landings during the period, 1966–'84.

3,145 tonnes in 1981, the corresponding percentages being 4 and 1 respectively (Fig. 1E).

Tamilnadu

This state ranks third in the landings of sciaenids at all-India level and first along the east coast of India with an average of 11,736 tonnes contributing to 16.26% of the all-India average catch (Table 1). The maximum landings were seen in 1982 (22,029 tonnes) and the minimum (5,495 tonnes) in 1971, the corresponding percentages to the total catch being about 9 and 3 respectively (Fig. 1D). The landings of sciaenids showed an increasing trend from 1975 to 1980 while a fluctuating trend was seen during other years.

Andhra Pradesh

With an average catch of 7,640 tonnes, this state ranks fourth (10.58%) in the landings of sciaenids, the minimum and maximum landings being 2,557 tonnes in 1968 and 12,358 tonnes in 1974 respectively (Table 1 and Fig. 2A). The percentage of sciaenid catch to the total catch in the state varied from 3 in 1968 to 10 in 1977 and 1978. The study has shown that while the catch from the mechanised boats along the Andhra coast increased in 1983 it registered a decrease in 1984.

West Bengal and Orissa

These two states jointly recorded an average catch of 4,341 tonnes of sciaenids during the period (Table 1) accounting for sixth place (6.01%). A maximum landing of 19,885 tonnes was recorded in 1984 showing an all time record. The landings during 1966–'84 showed a highly fluctuating trend, the last two years recording significantly higher catches. The percentage of the catch of scieanids to the total catch in these states varied from 3 in 1967 to 23 in 1984 (Fig. 2B).

Karnataka

This state could claim only seventh place (2.89%) in the landings of sciaenids among the maritime states of India and fourth along the west coast with an average catch of 2,086 tonnes (Table 1). The landings experienced considerable fluctuations year to year during the period 1966–'84. Except in 1974, 1976 and 1980 the catch was less than 3,000 tonnes (Fig. 2C). It is also noticed that excepting two years (1968 and 1974) the percentage contribution of sciaenids to the total catch in the state never exceeded 3% level.

Goa

An estimated average catch of 1,329 tonnes of sciaenids was noticed during the period, 1966-'84 the minimum and maximum landings being in 1969 and 1978 respectively (Table 1). Although the percentage contribution to the total catch was less than 1% prior to 1973, increased landings were noticed in the subsequent years (Fig. 2B). This increase in the catch can be attributed to the corresponding increase in the number of operations of mechanised boats in this Union Territory *(Mar. Fish. Infor. Serv., T & E Ser., No.* **3,** 1978 and *No.* **30,** 1981).

Pondicherry

The catch particulars available for this Union Territory indicate an average landing of 484 tonnes during the period, 1966–'84. The fluctuating catch trend varied from 212 tonnes in 1975 to 895 tonnes in 1969 (Table 1). The percentage contribution to the state's total catch which was of the order of 8 in 1968 and 1969 sharply declined to 3 in 1974–'75 and 1979–'80 periods.

Discussion

The sciaenids form an important group of fishes in the marine fish landings in India. Earlier investigations by Nair and Banerji (1966) and Rao (1973) indicated 5.45% and 3.64% of the sciaenid landings to total fish landings during 1950–'62 and 1956–'63 periods respectively. The present study reveals an average catch of about 72,200 tonnes during the period, 1966–'84 forming 6% of the all-India total marine fish catch. Catch trends during the period reveal highest catch in 1975 with 1.15 lakh tonnes. In general, the sciaenid landings indicated maximum yield from 1973 onwards which can be attributed mainly to the operations of more number of mechanised boats along the Indian coasts. Since then, the mechanised boats have gradually increased and at present an estimated number of 19,000 mechanised boats are in operation along the Indian coasts *(Mar. Fish. Infor. Serv., T&E Ser., No.* **30,** 1981). Although trawling is almost exclusively carried out for prawns on account of their export value, sciaenids are also caught along with other demersal fishes. The percentage contribution of sciaenids to the total catch from 1973 did not show variation although 1975 recorded a maximum of 8%.

West (1973) estimated that out of 117×10^3 tons of demersal fish potential in the shelf srea off north east

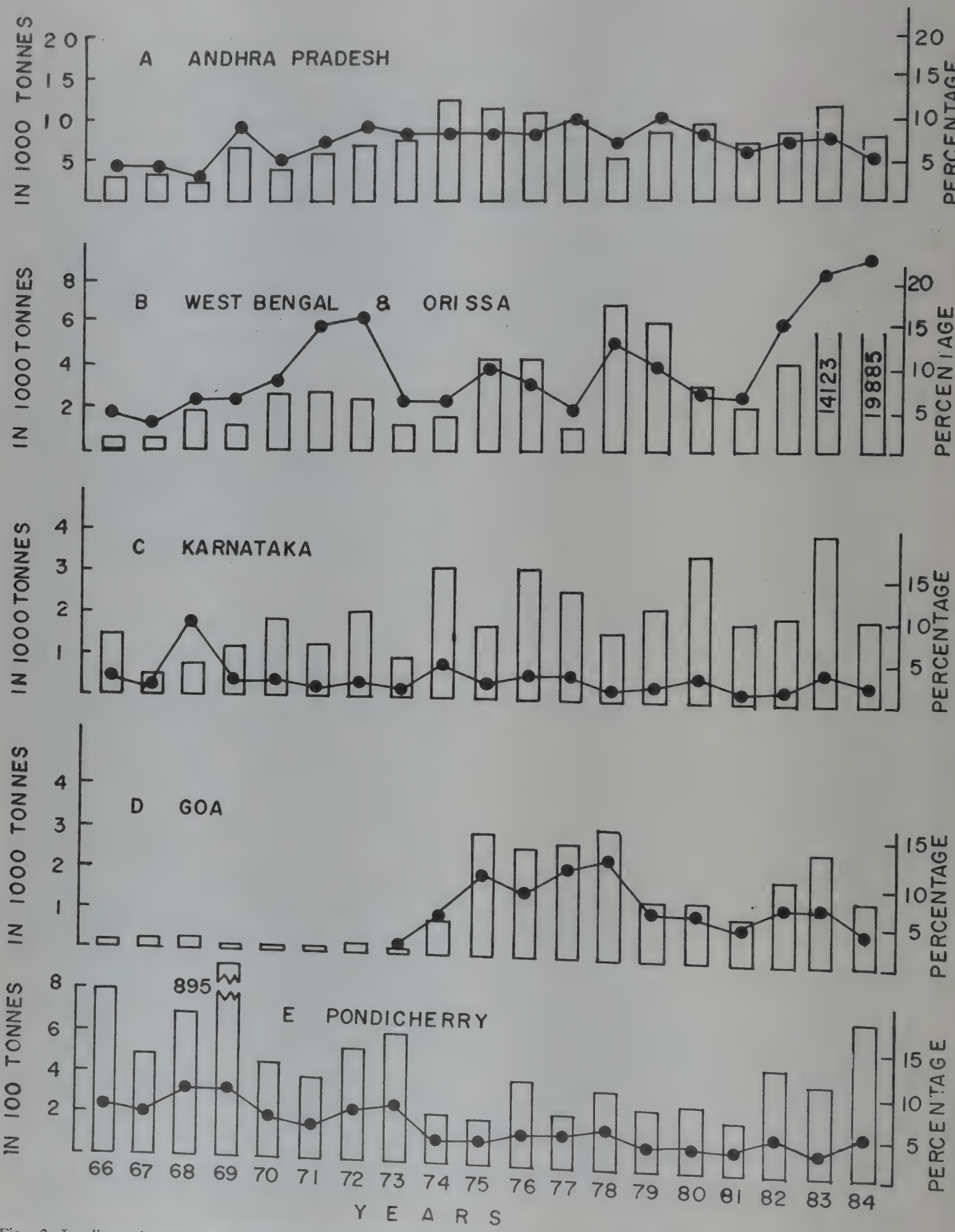

Fig. 2. Landings of sciaenids in the states of Andhra Pradesh, West Bengal & Orissa, Karnataka and union territories of Goa and Pondicherry and the percentage contribution to total landings during the period, 1966–'84.

coast of India, 16.7 x 10^3 tons were constituted by sciaenids thereby indicating the potential stock of this fishery along this coast. Comparatively better grounds for sciaenids have been recorded towards the north, while exploitable areas are present in the southern zone also mainly at 17°40′ N and in zone north of 19°40′N.

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MECHANISATION OF TRADITIONAL CRAFTS WITH OUTBOARD MOTORS AT VIZHINJAM*

Introduction

Vizhinjam, 16 km south of Trivandrum in Kerala State, is an important fish landing centre where, because of a bay protected by breakwaters, fishing goes on even during the monsoon period. Good marketing outlets are available at nearby places such as Balaramapuram, Trivandrum and adjacent towns. The fishery is artisanal, employing catamaran, dugout canoe and plank-built boat. At present eleven types of traditional gears are employed in this area, the major ones being boat seine, drift net and hooks and line *(Mar. Fish. Infor. Serv.,T & E Ser.,* **38**: 1982). Mechanisation came late to Vizhinjam, while in the nearby places like Sakthikulangara and Kolachal mechanised fishing had been well established even years back. Vizhinjam fishermen were rather cautiously avoiding mechanisation since they feared that favouring mechanised fishing may invite big business men into the field which may affect the traditional fishing adversely. They also shared the early fears of the traditional fishermen that mechanised trawling scared away the fish shoals from inshore waters. However, in recent years a few mechanised boats have started operating from Vizhinjam employing the traditional drift net. But only few fishermen could afford the needed high capital investment and operational costs.

By about September, 1982, five traditional crafts fitted with 'Yamaha' outboard motors started operating from this area. The increased propulsion provided by the motor enabled the fishermen to reach distant fishing grounds, unexploited by the traditional crafts, and to bring better catches. Due to the high profit obtained by the fishermen and low capital and operational costs for the outboard motor when compared to those of mechanised boats, the mechanisation of traditional crafts with outboard motor became acceptable to the fishermen. Now in the course of one and a half years the total number of outboard motors at this centre increased to about sixty. This trend is bound to rise, in view of the prospect of the fishing harbour under construction and the additional attendant facilities, which would be an added incentive for further modernisation of the fishing fleet and fuller utilization of these facilities. Hence the present study on the mechanisation of traditional crafts with outboard motor and its prospects at Vizhinjam is an essential and timely step in assessing the impact of mechanisation on the traditional fishery.

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Fishing methods

The outboard motor fitted on the traditional crafts at Vizhinjam is Yamaha kerosene outboard motor (Model 8 B.K, 7 H.P.). Eventhough both catamaran and plank-built boats could be fitted with an outboard motor, plank-built boats are preferred because they provide more space for the gear and the catch. Though other gears are also operated from these motorised crafts, hooks and line is the principal gear operated throughout the year. Hence the data, collected from only those units, both mechanised and non-mechanised, which operated hooks and line during 1983, were considered for this study.

Fishermen, in the mechanised craft leave the shore for fishing at about 0500 hrs and return any time between 1300 and 1800 hrs, depending on the distance to the fishing grounds and the quantity of the catch obtained. Mechanised crafts generally go about 20–25 km off Vizhinjam to areas of 60–80 m depth, whereas the non-mechanised traditional crafts are confined to about 10 km from the shore and a depth range of 40–50 m. The number of actual fishing days in a month ranged from 20 to 25 for both the types of units.

Fish catch

The month-wise effort (that is the number of trips by each type of craft) and catch (kg) of hooks and line operated by non-mechanised and mechanised crafts are given in Table 1. It could be seen that both types of crafts operated all through the year and both brought in the major part of the yearly landings (55 to 80%) during July to October. The month-wise trend of the catch per trip in non-mechanised and mechanised crafts is presented in Fig. 1. It is observed that the catch per trip of powered crafts is higher during all the months.

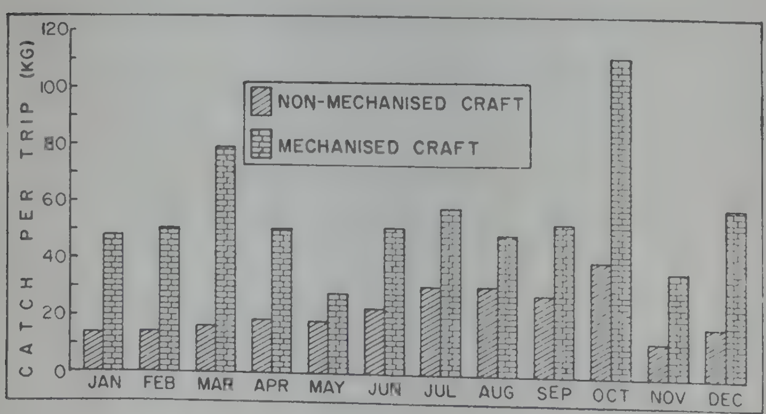

Fig. 1. Month-wise trend of catch per trip in the non-mechanised and mechanised traditional crafts.

Table 1. *Month-wise effort and catch of hooks and line operated by non-mechanised and mechanised crafts during* 1983

Months	Non-mechanised crafts		Mechanised crafts	
	Effort (trips)	Catch (kg)	Effort (trips)	Catch (kg)
Jan.	6,647	90,022	100	4,862
Feb.	5,705	81,810	158	8,017
Mar.	6,716	1,10,469	62	4,925
Apr.	7,200	1,34,777	73	3,681
May	6,433	1,15,990	16	457
Jun.	6,066	1,39,040	153	7,859
Jul.	6,898	2,12,189	853	49,793
Aug.	9,035	2,80,709	1,174	58,397
Sep.	6,533	1,84,862	1,010	53,434
Oct.	7,828	3,13,469	899	99,932
Nov.	5,175	63,533	386	14,180
Dec.	4,822	84,713	155	9,172
Total	79,058	18,11,583	5,039	3,14,709

Species composition

The annual catch, catch per trip (kg) and percentage composition of dominant groups of fish landed by hooks and line operated from non-mechanised and mechanised crafts are given in Table 2. About 25 major groups of fish supported the fishery by non-mechanised units. The carangid fishery ranked foremost, with annual landings of 817.5 tonnes, forming 45% of the total fish landings by hooks and line. *Decapterus dayi* was the most dominant carangid species accounting for 73.6% followed by *Selar crumenophthalmus* (6.6%), *Selar mate* (2.8%) and other carangids (16.8%). The next important group in the order of abundance was *Nemipterus* spp. with an annual landing of 214.3 tonnes which formed 11.8% of the total catch. Tunas made up the third major group forming 141.9 tonnes which constituted 7.8% of the total landings. Among tunas, *Auxis rochei* formed 48.8%, *Euthynnus affinis* 28.4%, *Sarda orientalis* 16.5% and other tunas 6.3%. The next important group was mackerel with an annual landing of 79.6 tonnes forming 4.4% of the total catch. Among the rest were cat fish (4%), *Dussumieria* spp. (3.4%), Balistids (2.4%), cuttle fish (2.3%), squids (2.2%), *Histiophorus* spp. and *Saurida* spp. (2.1%).

In the hooks and line fishery by mechanised crafts about 19 major groups of fishes constituted the catch (Table 2). As in the case of the traditional crafts,

Table 2. *Annual catch, catch per trip and percentage composition of dominant groups of fish landed by hooks and line operated from non-mechanised and mechanised crafts during* 1983

Fish groups	Non-mechanised crafts			Mechanised crafts		
	Annual catch (kg)	Catch per trip (kg)	%	Annual catch (kg)	Catch per trip (kg)	%
Sharks	30,243	0.38	1.67	5,665	1.12	1.80
Rays	18,568	0.23	1.02	—	—	—
Dussumieria spp.	61,570	0.78	3.40	13,094	2.60	4.16
Decapterus spp.	6,01,933	7.61	33.23	1,63,542	32.46	51.97
Selar mate	23,007	0.29	1.27	2,804	0.56	0.89
S. crumenophthalmus	54,851	0.69	3.03	—	—	—
Other carangids	1,37,749	1.74	7.60	11,826	2.35	3.76
Mackerel	79,579	1.01	4.39	5,762	1.14	1.83
Euthynnus affinis	40,312	0.51	2.22	11,638	2.31	3.70
Auxis rochei	69,295	0.88	3.83	12,390	2.46	3.94
Auxis thazard	—	—	—	3,013	0.96	0.59
Thunnus albacares	—	—	—	3,269	0.65	1.04
Sarda orientalis	23,429	0.30	1.29	—	—	—
Other tunas	8,908	0.11	0.49	991	0.20	0.31
Histiophorus spp.	36,960	0.47	2.04	—	—	—
Elacate niger	23,088	0.29	1.27	—	—	—
Tylosurus spp.	18,526	0.23	1.02	—	—	—
Coryphaena spp.	22,410	0.28	1.24	—	—	—
Cat fish	72,443	0.92	4.00	8,840	1.75	2.80
Saurida spp.	37,611	0.48	2.08	6,475	1.28	2.06
Lethrinus spp.	13,875	0.18	0.77	5,757	1.14	1.83
Lutianus spp.	25,413	0.32	1.40	7,490	1.49	2.38
Epinephelus spp.	—	—	—	7,275	1.44	2.31
Nemipterus spp.	2,14,318	2.71	11.83	36,103	7.16	11.47
Therapon spp.	20,334	0.26	1.12	—	—	—
Balistids	43,993	0.56	2.43	—	—	—
Sepia spp.	42,351	0.54	2.34	1,859	0.37	0.59
Loligo	39,662	0.50	2.19	—	—	—
Miscellaneous	51,155	0.65	2.82	6,916	1.37	2.20
Total	18,11,583	22.91		3,14,709	62.50	

carangids ranked first among the different fisheries by this gear. The annual carangid landing was 172.2 tonnes forming 56.6% of the total fish landings. *Decapterus dayi* was the most dominant species accounting for 91.8%, *Selar mate* (1.6%) and other carangids (6.7%). The group next in abundance was *Nemipterus* spp. with an annual landing of 36.1 tonnes forming 11.5% of the total landings. Tunas formed the third important group with an annual landing of 31.3 tonnes which formed 10% of the total catch. Among tunas *Auxis rochei* constituted 39.6% followed by *Euthynnus affinis* (37.2%), *Thunnus albacares* (10.4%), *Auxis thazard*

(9.6%) and other tunas (3.2%). Perches were the fourth important group with an annual landing of 20.5 tonnes forming 6.6% of the total catch. *Lutianus* spp. constituted 36.5% of the perch catch followed by *Epinephelus* spp. (35.4%) and *Lethrinus* spp. (28.1%). Other important groups in the order of abundance were *Dussumieria* spp. (4.2%), cat fish (2.8%) and *Saurida* spp. (2.1%).

From the Table 2, it can be seen that the variety of species which constituted the fishery of non-mechanised units was more when compared to that of the mechanised units. Eventhough the quality fishes like carangids, tunas and perches formed the abundant groups in both the types of units, the catch per trip for these groups in mechanised crafts was much higher than that of the non-mechanised crafts (Fig. 2). The yellowfin tuna *(Thunnus albacares)* and perches of the group *Epinephelus* were obtained only from mechanised crafts.

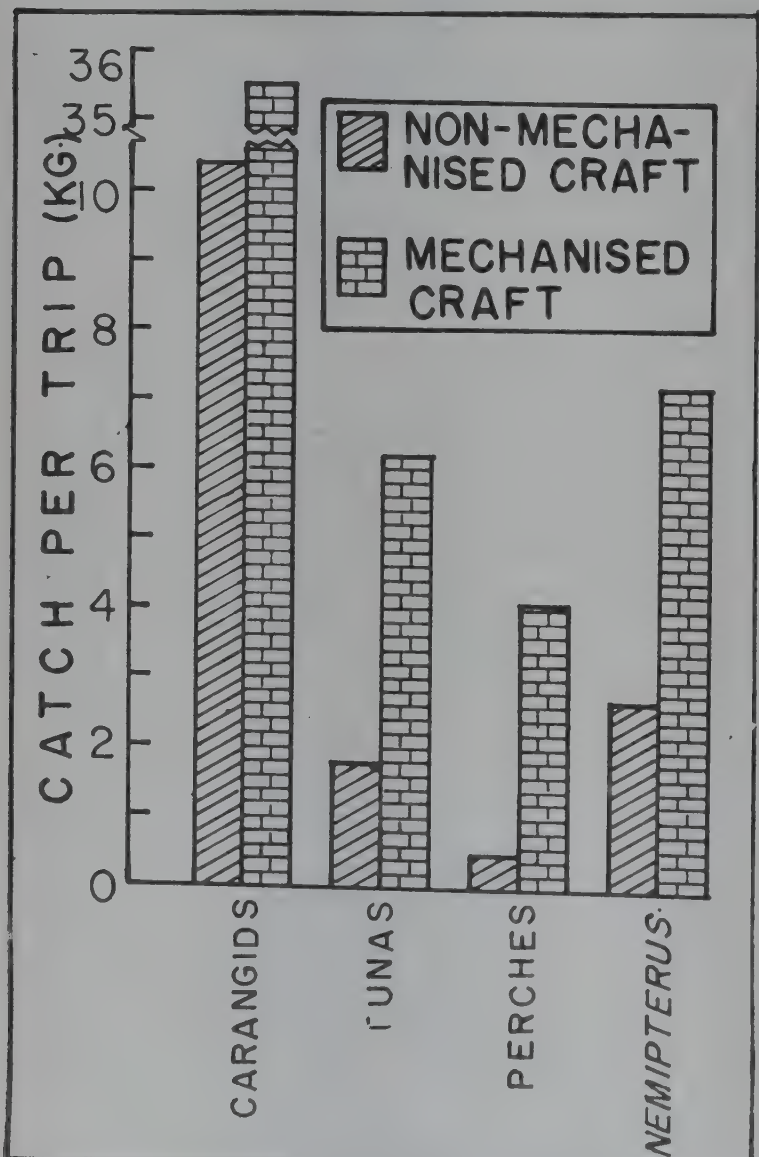

Fig. 2. Average catch per trip of four major groups of fishes landed by non-mechanised and mechanised traditional crafts.

Socio-economic aspects

A comparative idea of the operational and maintenance costs of both the types of crafts and the problems associated with these is necessary for understanding certain socio-economic aspects of the fishermen engaged in hooks and line fishing at Vizhinjam. The fuel requirements for the outboard motor per trip is 20 to 25 litres of kerosene and 1.5 to 2 litres of petrol. The average operational expenditure which includes the cost of fuel, maintenance of the motor and cost of bait would be about Rs. 100. The gross income from a mechanised craft ranges from Rs. 250 to 1,500 per trip with an average income of Rs. 600. The net income per trip would be Rs. 500. The number of crew in a mechanised unit is usually four. The profit will be divided among the owner and crew of the unit in such a way that the owner gets two shares and crew get one share each. If the owner himself is one among the crew, which is the usual practice, he gets three shares. Thus on an average the owner gets Rs. 250 and the crew Rs. 83.3 each per trip. On the otherhand the gross income by the non-mechanised crafts ranged from Rs. 60 to 200 per trip with an average income of Rs. 100. The number of crew in a non-mechanised unit is two. The income is divided into three equal shares and the owner of the unit gets two shares (Rs. 67), if he is also one among the crew as is the usual practice in Vizhinjam, and the other crew Rs. 33. Thus the profit obtained per trip by the owner of the unit from a motorised craft is about 3.7 times higher and that of the crew 2.5 times higher than their counterparts in non-mechanised crafts. The better returns of mechanised crafts is mainly because of the high price fetched by the quality fishes. The profit may naturally be high when it operates 'konchu vala' and special hooks for squids and cuttle fishes.

Now the idea of reaching extended and unexploited fishing grounds with less physical labour and the resultant increased catch obtained, has made the fishermen to take to motorisation. But they point out some difficulties they are faced with, like the high capital involved in the initial stage, nonavailability of bank loans, inadequate supply of kerosene at subsidised rate and lack of local facilities for repairs and procurement of spares. So they demand help in these respects from the government side.

General remarks

The introduction of nearly sixty outboard motors within the short period of one and a half years at Vizhinjam clearly indicates the fishermen's growing conviction

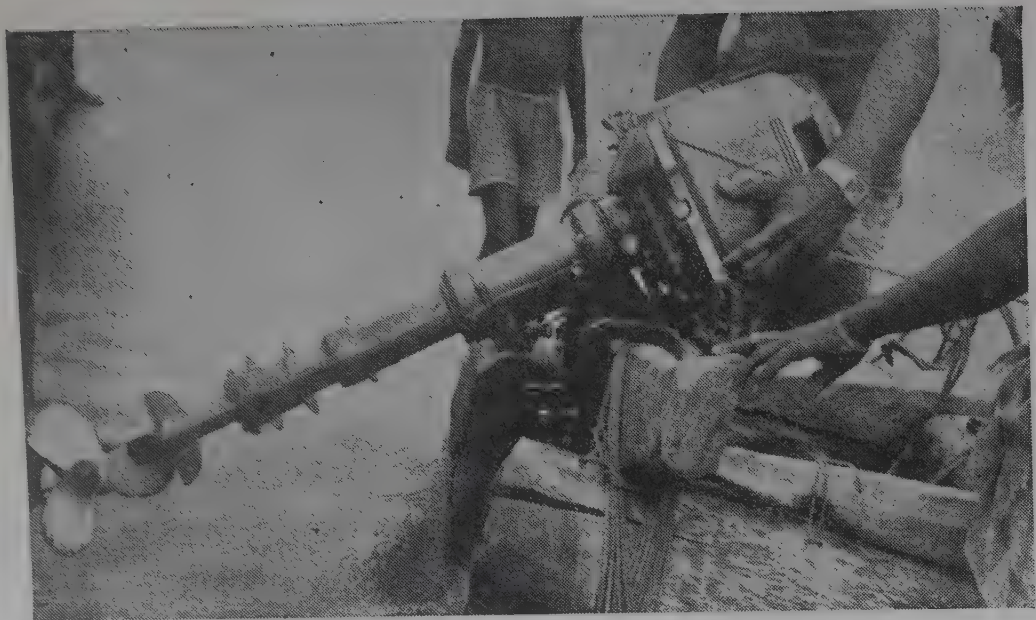

Fig. 3. Outboard motor being fitted to a catamaran.

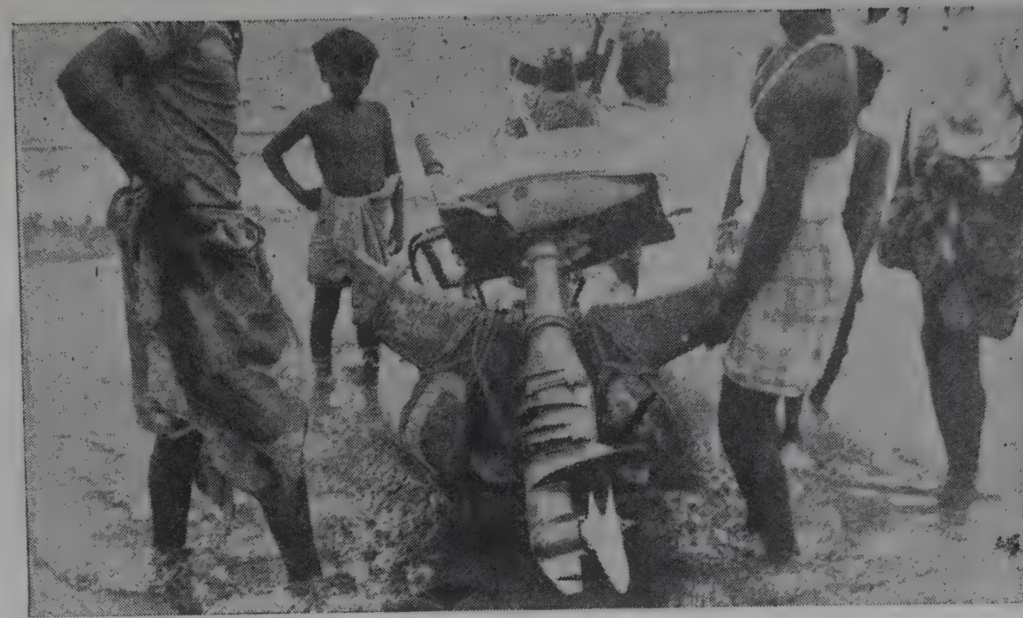

Fig. 4. Catamaran fitted with outboard motor being launched for a fishing trip.

Fig. 5. Plank-built canoe suitably modified and fitted with outboard motor.

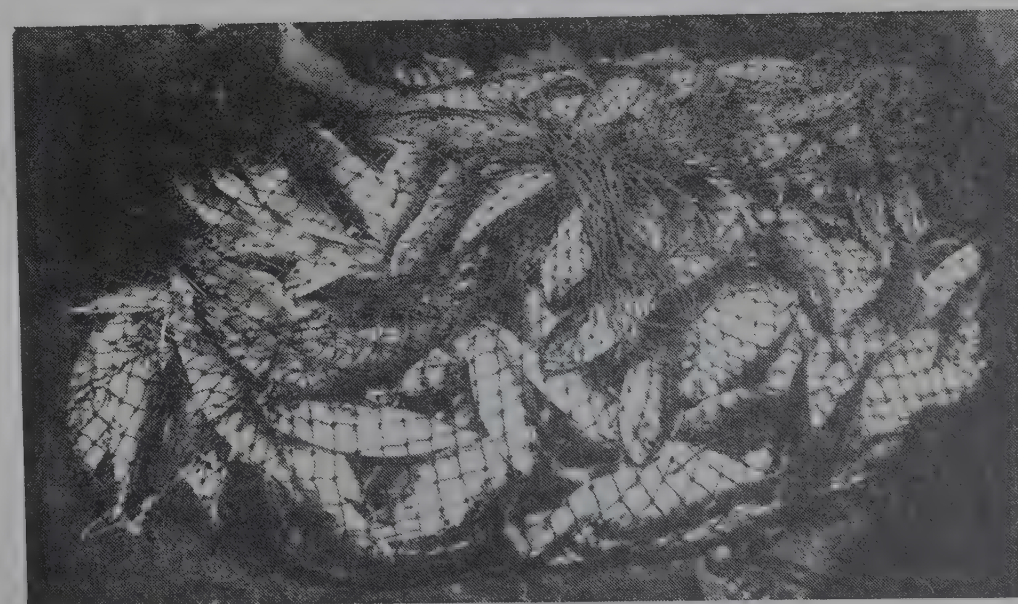

Fig. 6. Hooks and line catch ready for auction.

about the advantages of mechanisation. Also, the nearshore fishing grounds being fully exploited, any increased fishing has to be in the unexploited grounds farther off. The results of the data analysed indicated a higher catch per trip for motorised crafts. It is also observed that three major fisheries; tunas, carangids and perches could be further developed at Vizhinjam by the extensive exploitation of the distant fishing ground currently being fished by the motorised traditional crafts.

The present state of mechanisation has not led to any clash between the fishermen of mechanised and non-mechanised units. This is mainly because the mechanisation was adopted by the traditional fishermen themselves and it is used only for easy accessibility to areas beyond the fishing grounds of non-mechanised units.

As mentioned earlier, the development of the fisheries harbour at Vizhinjam, would be an added impetus to mechanisation. As is now realised, no mechanisation of fishing activity can be successful neglecting the traditional fishermen. Hence the present attitude of the traditional fishermen showing an inclination towards mechanisation is no doubt a positive trend and fisheries developmental activities in this area could be enhanced by accelerating this trend by means of incentives from government as well as fisheries welfare agencies for the procurement of outboard motors and for provisions of auxiliary facilities.

The authors wish to express their sincere thanks to Dr. E. G. Silas, former Director, C.M.F.R.I., for encouragement and to Shri C. Mukundan, Vizhinjam Research Centre of C.M.F.R.I. for suggesting improvements in the manuscript. We are also grateful to S/Shri. P.S. Sadasiva Sarma, A. K. Velayudhan, K.T. Thomas and Kumari T. A. Omana for the help rendered in the collection of catch statistics.

WATER POLLUTION AND FISH MORTALITY IN ENNORE ESTUARY, MADRAS*

Mass mortality of fishes and aquatic organisms occur in Ennore estuary (13°14′N 80°20′E) from time to time due to water pollution. One such instance was observed from 5-9-1983 to 8-10-1983. Dead fishes were found floating and spread out for about 2 km distance in the region between Ennore Thermal Power Station and Ennore Railway Bridge (Fig. 1). The fish kill was particularly extensive on 30-9-1983. A brief account of this incident with analysis of relevant parameters to find out probable causes is given here.

Pollution problems are encountered in Ennore estuary as it receives industrial effluents and domestic sewage mostly in untreated condition. These affect water quality and living organisms. Major industries like Kothari Chemicals, Alkali Chemicals, Madras Refineries, Madras Fertilizers, Petrochemical industries, many other private industries and Government installation such as Ennore Thermal Power Station are located around Ennore estuary. It has been estimated that about 4,49,000 litres/day of industrial effluents carrying heavy metals are let out into this estuary by these industrial establishments. Another source of pollution that poses danger to fishes and other aquatic life is the flow of domestic sewage, and about 4 million litres/day are discharged into this estuary (Tamil Nadu Water Supply and Sewerage Board, Report 1980).

Eventhough the bar mouth of this estuary is kept open throughout the year by dredging operations by Ennore Thermal Power Station for maintaining free flow of sea water into this estuary, a large number of fish, prawn and other organisms die every year in this estuary due to water contamination. The physico-chemical characteristics of the water such as temperature, salinity, dissolved oxygen, pH and water transparency were examined besides heavy metal concentrations and their consequent impact on the mortality of fishes in the vicinity of industrial and sewage waste discharge points. Representative samples of dead fishes were collected from various stations of the estuary such as Ennore Thermal Power Station, Buckingham Canal discharge point, railway bridge, travellers bungalow and bar mouth of the estuary. The percentage intensity of dead fishes was high (70%) at the Buckingham canal discharge point.

*Prepared by D.B. James, P. Nammalwar and P. Thirumilu, Madras Research Centre of C.M.F.R.I., Madras.

The dead fishes collected, with their size range are as follows (Fig. 2): *Liza macrolepis* (85–265 mm), *Liza cunnesius* (65–100 mm), *Liza tade* (60–85 mm), *Rhynchorhamphus marginatus* (80–95 mm), *Etroplus suratensis* (50–70 mm), *Tilapia mossambica* (95–105 mm), *Leiognathus fasciatus* (55–90 mm), *Tetrodon immaculatus* (40–50 mm), *Triacanthus brevirostris* (65–70 mm), *Tachysurus jella* (40–45 mm), *Tachysurus dussumieri* (40–50 mm), *Platycephalus serratus* (110–205 mm), *Platycephalus biomaculatus* (110–190 mm), *Ambasis commersoni* (60–75 mm), *Anguilla bicolar* (700–900 mm) and *Scylla serrata* (50–60 mm).

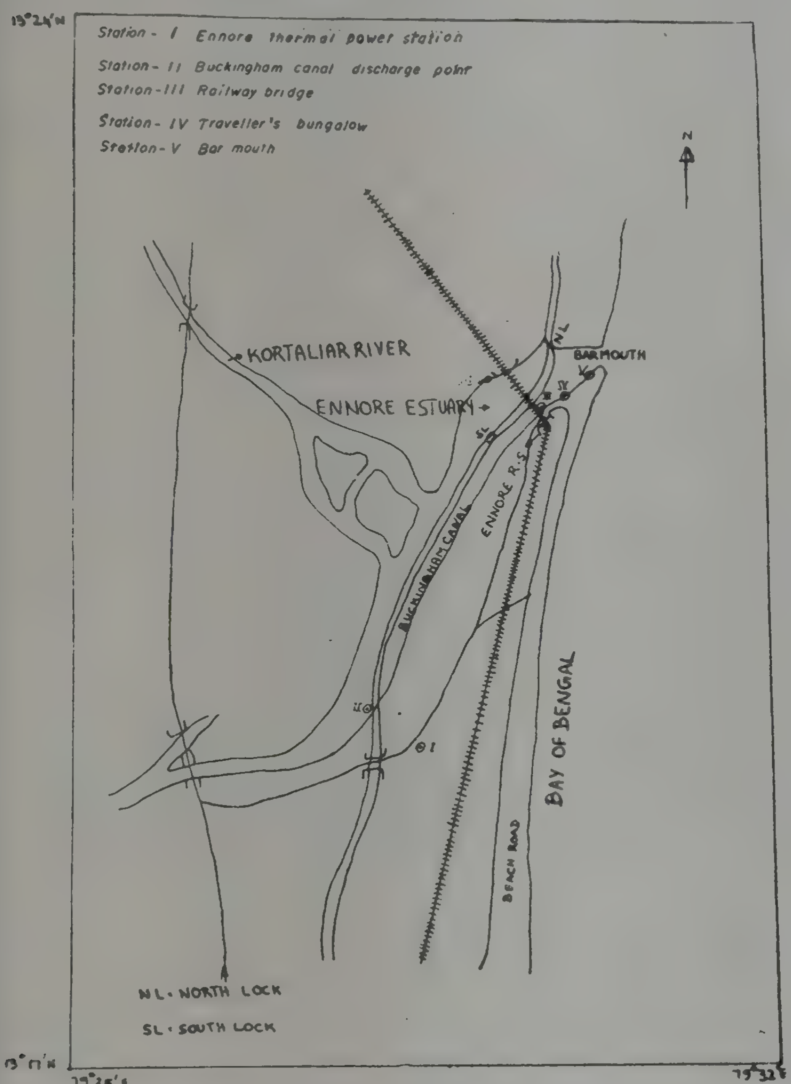

Fig. 1. Map showing location of sampling stations in Ennore estuary, Madras.

The analysis of various samples showed that temperature of water ranged from 30.0 to 33.6°C, salinity between 24.30 and 37.63‰ and dissolved oxygen content from 4.28 to 5.44 ml/1. The pH ranged from 7.67 to 8.11. The secchi-disc depth used as a measure of transparency of the water ranged from 31 to 62 cm. Further, the distribution and concentration of various heavy metals of the water in Buckingham Canal discharge point where the percentage intensity

Fig. 2. Fish mortatity in Ennore eastuary, Madras.

of fish mortality was high (70%) were analysed. They are ranked as follows: Mg > Na > K > Al > Pb > Fe > Cd > Zn > Sb (51.2, 20.0, 9.8, 7.8, 0.9, 0.3, 0.2, 0.04 and 0.01 ppm respectively). The concentrations of heavy metals like Mg, Al, Pb, Zn and Cd were found to be higher when compared to natural concentrations in sea water. The possibility of the presence of increased levels of these heavy metals in the water can be surmised, as many industries release effluents, and Buckingham Canal discharges domestic sewage wastes. The mass mortality of fishes occurred whenever the vents were opened to release the water from the Buckingham canal into the estuary. This is usually done during monsoon period to relieve the pressure on the bunds of Buckingham canal. As a result, the organic debris and some heavy metals in the water at the bottom would be churned up; an activity that usually takes place, which is indicative of excessive pollution. Thus based on the present investigation, it may be stated that the presence of some metallic elements, with their synergistic effects would have poisoned the water resultung in the mass mortality of fishes and prawns and dislocation of the most bottom fauna from their habitat in this estuary. The role played by the low oxygenated water brought by the process of churning in the Buckingham canal during monsoon season cannot be overlooked.

ON THE OCCURRENCE OF *DROMIA DEHAANI* RATHBURN IN TRAWLER CATCHES OFF BOMBAY COAST*

Dromia dehaani Rathburn, a crab ('Red kekada' in Maratti) has been reported from both the coasts of India but only in small numbers. Its landing in fairly large quantities by trawlers at New Ferry Wharf, Bombay, seems to be of great significance mainly because of two reasons, (1) its unusual large scale landings and the subsequent awareness among the public have made it an edible resource and (2) the presence of berried females with large number of eggs pointed to the possibility of its occurrence in deeper regions as a potential resource.

The crab is rather large with carapace broader than long. The four antero-lateral teeth are sub-equal but distance between 3rd and 4th is much greater than those between first and second, and second and third. The surface immediately behind front is smooth and even. Tips of chelipeds are distinctly pinkish in colour.

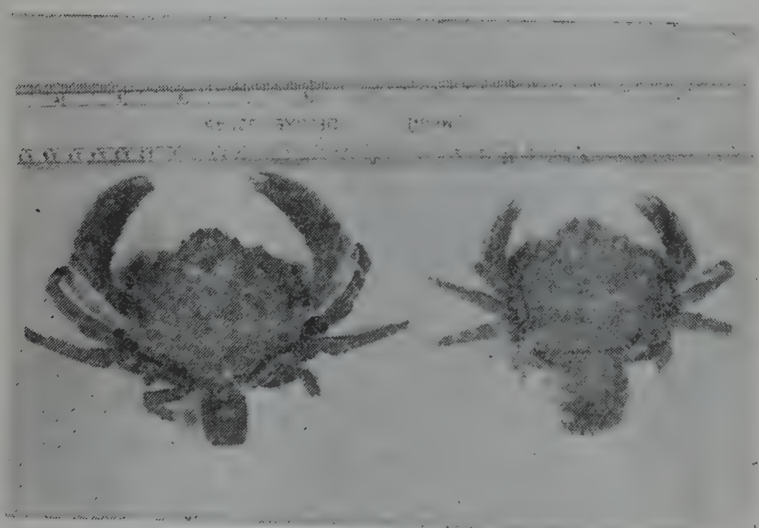

Fig. 1. *Dromia dehaani*- dorsal view of male and female.

The trawlers which brought the crabs were operated off Harnai–Murud coast at a depth range of 40–60m. The estimated landings amounted to 30 kg per day from 10 units. A representative sample was collected from the centre and was analysed. Biological observations made are as follows.

Name of species	Sl. No.	Carapace length (mm)	Carapace width (mm)	Weight (g)	Sex
Dromia dehaani	1.	46	52	35	F (berried)
	2.	48	53	50	F
	3.	57	65	80	F
	4.	55	64	95	F
	5.	60	72	145	M

The specimens were large in size, the biggest being a male with a weight of 145 g and stout chelipeds (Fig. 1). The average weight was estimated at 81 g. Two of the four females were in berried condition with numerous small eggs. The number of eggs carried by females was estimated to be about a lakh.

This resource is relatively new and so does not command good price as in the case of large sized portunid crabs. However, they were sold at a rate of Rs. 0.50–1.00 per specimen based on the size of the crab. It is quite probable that this species may command better prices in future due to consumer acceptance. The edible nature of this species is reported for the first time in Bombay. Good landing of this species can be expected in future when deeper regions are explored by trawlers.

The authors are deeply grateful to Dr. M.J. George, Senior Scientist and Head of Crustacean Division (Rtd.) CMFRI, Cochin for kindly going through the manuscript. They are also thankful to Dr. E.G. Silas, former Director, CMFRI, for his interest in the preparation of this note.

*Prepared by M. Aravindakshan, C. J. Josekutty and J. P. Karbhari, Bombay Research Centre of C.M.F.R.I., Bombay.

SEA EROSION AT BAITKHOL (KARWAR) AND ITS EFFECT ON INDIGENOUS FISHING*

In the wee hours of 4th June 1984, the sleepy town of Karwar was experiencing light showers, and the Karwar Bay was slightly rough as to be expected during the pre-monsoon period. As the hours passed by, menacing waves started furiously lashing against the Baitkhol and Karwar shores. By 0900 hrs waves as high as 2 m started pounding the NH 17 subjecting it to a severe test. However, the anger of the sea was centred between the Karwar Research Centre of CMFRI in the south and the Marine Engineer's Office in the north, a stretch of length extending about 0.3 km. Within no time the waves not only smashed the parapet wall bordering the western side of the road but also inundated the area which caused breaches in small patches at several points. In this process, many small huts of fishermen on the other side of the road were destroyed. There

Fig. 1. The Karwar Bay in fury.

was an imminent danger of Karwar being cut off from the southern part of the country. This situation prevailed for the next four days during which period the northern part of the Baitkhol shore from where the indigenous crafts used to operate during the monsoon period was completely eroded. However, the local authorities took immediate steps in dumping boulders along the shore to prevent further erosion and damage to the NH. The situation was brought under control

Fig. 2. Nothing forms an obstacle for a furious sea.

by middle of the month. The unprecedented roughness of sea might have been due to the non-construction of breakwater walls before taking up the dredging operations in the Karwar Bay as a part of the developmental work of Karwar port.

In this connection it may be mentioned that the Baitkhol shore was famous for *rampan* operations in the yester years. Of late, this area was used for operations of *yendi* (small shore-seine) and dragnets, especially during the monsoon season. Because of the erosion of the fish landing area, the fishing operations were completely stopped thus affecting the earnings of fishermen. However, by the middle of August, a good stretch of sand dune of about 200 m long was emerged to south of the former shore.

*Prepared by M. H. Dhulkhed, Karwar Research Centre of C. M. F. R. I., Karwar.

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CONTENTS

Front cover photo:
A prawn culture pond in salt pan area at Veppalodai, Tuticorin showing the catching pit for easy harvest.

Back cover photo:
A view of salt pan area at Veppalodai, Tuticorin where prawn culture has been carried out. In the background are heaps of salt.

PROSPECTS OF PRAWN CULTURE IN SALT PAN AREAS

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John Motha

Pablo Prawn Farm, Veppalodai, Chidambaranar District, Tamil Nadu

Introduction

The Central Marine Fisheries Research Institute has been undertaking several investigations in recent years to improve the existing aquaculture practices in the country, and has evolved new indigenous techniques for farming prawn on modern scientific lines. One of the major objectives of the Institute is to disseminate the findings at different levels through extension services. The present work is one such contribution. An awareness has recently been created along the southeast coast of Tamil Nadu for the utilisation of saline fallow coastal lands including salt pan areas for culture practices. The land and water in the low lying areas adjacent to salt pan areas along the coast of Gulf of Mannar between Pinnakayal in the south and Valinokkam in the north, have been assessed for their suitability for prawn farming.

Based on the resource potentials, Nair *et al.* (1974) have observed the possibilities of marine fish and prawn culture in salt pan areas at Tuticorin. Suseelan (1975) reported on the prawn culture practices in salt pan reservoirs of Cape Comorin region. A number of published accounts of seed resources and culture of prawns in salt pan areas are available now (Rao and Narasimham, 1978; Mohamed *et al.*, 1980; Marichamy and Rajapackiyam, 1982; Victor and Venkatesan, 1982). Information on the preliminary experiments in semi-intensive culture of prawns in salt pan areas at Veppalodai has been presented elsewhere (Marichamy, 1986). Several improvements have been made subsequently to enhance the production potential under intensive culture system and the present account describes the various aspects including the strategies evolved and economics of this profitable venture, highlighting the prospects of prawn culture in high saline waters.

Location, construction and preparation of ponds

About 800 hectares of land on the northern side of Kallar river are used as salt pans by M/s Veppalodai Salt Corporation at Veppalodai, north of Tuticorin in Chidambaranar District, Tamil Nadu. The salt pan reservoirs support a variety of fish and prawn resources. Water and soil characteristics are suitable for culture practices within the factory area but the major constraint is predation by migratory birds as the depth of water in the ponds is very low. In addition to this, predatory crabs and snakes present in the surrounding water logged area enter the reservoirs. Another factor for not considering the existing ponds for culture is that the addition of inorganic or organic fertilizers for raising plankton bloom in intensive culture practices, may affect the quality of salt produced. Considering all these factors a new site adjacent to the salt industry was developed exclusively for prawn farming. Soon after completing the preliminary experimental culture in a limited area, 3.3 ha of derelict land on the southern side of the river was converted into ponds for intensive prawn farming. Full advantage of the existing natural conditions was taken while preparing the lay-out for the farm. The ponds are located 50 m away from the main river. The mud excavated from the draining trenches and catching pit of the rearing ponds was used for raising bunds without scraping the top fertile soil too much. The bottom of the ponds was levelled by a tractor. Gradient slope was given towards the catching pit and draining sluices. The ponds were ploughed well for making the soil soft to promote algal development. Ponds are rectangular in size and provided with three inlets and three outlets of PVC pipe of 30 cm diameter in the bunds of opposite sides. At the western end, one 5 HP motor with a specially designed Vedaranyam type of pump set (with the motor kept at a higher level than the pump and a delivery pipe of 25 cm diameter),

having a high rate of pumping efficiency was fitted and this was sufficient to meet the water requirements for three ponds of the area of 2 ha. On the eastern side, a separate 5 HP oil engine was used to feed water for two ponds of the area of 1.3 ha. Since the ponds are constructed at an elevated place, water is lifted from the creek to a height of 2.5 m. This arrangement helps to drain the ponds perfectly at the time of harvesting. The system further helps for sun drying/baking the ponds so that all organic matter is completely oxidized. The sea water was properly screened and the entry of major organisms was prevented by fitting fine meshed velon screens at the inlets and outlets of the pumps. An average water depth of 0.4–0.7 m, was maintained in the rearing ponds. Lime treatment was not made since the soil pH was optimal at 7.5. After completing the tilling works, organic manure (dried poultry dung or cow dung) was spread in the ponds at the rate of 750 kg/ha. Water level was gradually increased and the development of bloom of phytoplankters or 'green water' was noticed on the fourth day after fertilization. The common nanoplankters were, *Synechocystis, Nanochloris* and *Chlorella* spp. The phytoflagellates were *Chlamydomonas* spp. and *Platymonas.* The benthic diatoms such as *Pleurosigma, Navicula, Mastogloia, Amphora* and *Oscillatoria salinarum* were also seen.

Culture experiments and stocking operation

The culture experiments were designed according to the availability of natural seed. February–May and August–October are the best periods for maximum collection of seed of *Penaeus indicus* from this region. The first set of culture experiments was carried out in one hectare area during August, 1985–January, 1986 and the second set during February, 1986–August/October 1986. The second crop normally covers longer period due to high salinity and slow rate of growth. A short interval of 20–25 days are available in between the culture experiments for preparing the ponds for subsequent stocking.

Table 1. *The results of culture experiments for* **P.** indicus

Particulars	Ponds			
	1	2	3	4
Size of ponds (m)	116.2 x 44.8	151.8 x 62.4	143.7 x 63.6	128.1 x 28.5
Area of ponds (ha)	0.5205	0.9472	0.9139	0.3677
Average water depth (m)	0.7	0.5	0.4	0.4
Date of stocking	1–3–1986	20–2–1986	25–3–1986	1–4–1986
Date of harvest	10–10–1986	10–10–1986	13–9–1986	13–9–1986
Days of culture	224	232	172	166
Size at stocking (mm)	22	15	25	25
Size at harvest (mm/g)	123.5/13.2	116/11	106/8	108/8.2
Rate of growth (mm/g/month)	13.6/1.7	14.4/1.4	14.1/1.4	15/1.5
No. of prawn seed stocked	66,500	1,15,000	1,35,000	55,000
Rate of stocking (per ha)	1,27,762	1,21,410	1,47,718	1,49,578
No. of prawn harvested	63,460	1,06,380	1,00,625	40,260
Percentage of survival	95.4	92.5	74.5	73.2
Total production (kg)	835	1,169	805	330
Rate of production(kg/ha/crop)	1,604	1,234	881	897
Total food supplied (kg)	5,945	7,592	4,347	2,372

The salt industry maintains continuous pumping of sea water from the adjoining creek and about 32 ha of salt pan reservoirs available within the Salt Corporation area formed the resourceful bed for the collection of required seed of *P. indicus* for farming. Wild seed were also collected from tidal pools and inlets of Tuticorin Bay and transported to the site by employing simple methods as described by Unnithan (1985). Collection and stocking operations of prawn seed were carried out in the morning hours since the rate of mortality increased with increase in water temperature. The particulars of stocking operations are given in Table 1.

Table 2. *Hydrology of prawn culture ponds*

Ponds Period	Water temp. at 0800 hrs (°C)		Salinity (‰)		Dissolved oxygen (ml/l)		pH		Productivity mg C/m³/day	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
1. Feb.–Oct. '86	27.1–32.2	28.4	38.00–49.30	43.28	2.69–4.48	3.60	7.72–8.36	8.04	390–2,213	986
2. –do–	26.8–32.5	28.5	38.74–48.65	42.53	2.08–5.01	3.63	7.70–8.20	8.03	325–2,045	858
3. Mar.–Sep. '86	27.0–32.5	28.7	37.27–49.00	43.98	2.55–4.85	3.77	7.60–8.25	7.94	244–1,055	702
4. April–Sep. '86	27.0–32.5	28.9	39.20–50.03	45.37	2.66–5.09	3.59	7.60–8.43	7.86	266–835	564

Table 3. *The trend of growth in* **P.** indicus *cultured in salt pan area*

No. of days after stocking	Pond 1				Pond 2				Pond 3				Pond 4			
	Average size		Growth rate		Average size		Growth rate		Average size		Growth rate		Average size		Growth rate	
	mm	g	mm	g	mm	g	mm	g	mm	g	mm	g	mm	g	mm	g
0	22.0	0.3	...	...	15.0	0.2	...	...	25.0	0.3	...	...	25.0	0.3	...	...
15	37.0	0.8	30.0	1.0	30.0	0.5	30.0	0.6	40.0	0.8	30.0	0.1	44.0	1.2	38.0	1.7
30	54.5	1.5	32.5	1.2	41.5	0.9	26.5	0.7	56.0	1.3	31.0	1.0	58.0	2.0	33.0	1.6
45	66.0	2.1	29.3	1.2	54.5	1.3	26.3	0.7	60.5	1.7	23.7	0.9	66.0	2.7	27.3	1.6
60	77.0	3.2	27.5	1.4	63.5	1.5	24.3	0.6	65.0	2.1	20.0	0.9	71.0	2.8	23.0	1.2
75	77.0	3.4	22.0	1.2	67.0	1.9	20.8	0.7	67.0	2.3	16.8	0.8	74.5	2.9	19.8	1.9
90	79.0	3.5	19.0	1.1	70.5	2.3	18.5	0.7	75.0	2.6	16.7	85.0	3.4	6.8	20.0	1.0
105	81.0	3.6	16.9	0.9	73.0	2.5	16.6	0.7	81.0	3.4	16.0	0.9	92.0	3.6	19.1	0.9
120	86.0	5.0	16.0	1.2	80.5	3.1	16.4	0.7	93.0	5.2	17.0	1.2	99.0	6.2	18.5	1.5
135	98.0	6.8	16.9	1.4	90.0	4.8	16.2	1.0	97.0	5.6	16.0	1.2	103.0	6.5	17.3	1.4
150	103.0	8.2	16.2	1.6	95.0	5.7	16.0	1.1	100.0	6.2	15.0	1.2	106.0	7.2	16.2	1.4
165	106.0	8.7	15.3	1.5	98.0	6.2	15.1	1.1	104.0	7.4	14.4	1.3	108.0	7.8	15.1	1.4
180	110.0	9.2	14.7	1.5	101.5	6.5	14.4	1.0	...	...	...	...	...	...	...	...
195	114.0	10.8	14.2	1.6	104.5	7.6	13.8	1.1	...	...	...	...	...	...	...	...
210	117.0	12.0	13.6	1.7	110.0	9.0	13.6	1.3	...	...	...	...	...	...	...	...
225	124.0	13.2	13.6	1.7	114.0	10.4	13.2	1.4	...	...	...	...	...	...	...	...

Intensive stocking was made in ponds 1 – 4. The size of the ponds varies from 0.37 ha to 0.95 ha. The average size of seed at stocking measured 15–25 mm and the rate of stocking varied between 1.2–1.5 lakhs/ha. Stocking operations were completed in four ponds during February–March, 1986. A maximum of 55,000 seed were released in the 0.37 ha pond on 1–4–1986. Stocking at high rate was purposely designed to see its effect on survival, growth and production when compared to low stocking density experiments completed earlier in the same environment. The seed were released directly into the rearing ponds and there was no need to acclimatize them because of the identical water characteristics at the collection centre and grow-out ponds.

Farm management

Water samples from culture ponds were analysed at weekly intervals. About one fifth of the volume of water was flushed daily for maintaining the quality of water and the rate of exchange was increased gradually during later phases of culture. As far as possible draining and pumping were arranged in the cool hours of the day. Water depth was 0.7 m in pond 1 and the average depth in rest of the ponds was 0.4–0.5 m only. Velon screen tied to water inlets and outlets were kept clean. The observations on essential water qualities are presented in Table 2.

Water temperature at the surface was 26.8–32.5°C with a monthly mean value of 28.4–28.9°C around 0800 hours. The salinity in the rearing ponds was always well above 38 ppt and reached maximum values of around 45–50 ppt on most of the days during April–June, 1986 due to increased evaporation as well as the closure of bar mouth frequently. The dissolved oxygen content varied from 3.59 to 3.79 ml/l and the pH measured around 8.00. The productivity of the ponds (measured by light and dark bottle method) was recorded in the range 244–2,213 mg C/m^3/day and a minimum level of 500 mgC/m^3/day was maintained on most of the days; under such conditions the colour of water was light green or blue green. Whenever there was a change in colour (transparent or pale brown) a fall in productivity values was noticed and quick arrangements were made to add organic manure at the rate of 20 kg/ha and inorganic fertilizers like urea and superphosphate, each at 5 kg/ha along the water edge of pond instead of spraying all over the pond. This was necessary for the development of the bloom. Excessive growth of algae was controlled by flushing as much

Fig. 1. Sea water being lifted from the creek.

quantity of water as possible. The presence of natural food in the form of microalgae and zooplankters in the ponds meet the food requirements of young prawns during the first three weeks after stocking. Thereafter, the pelletized feed obtained from TOMCO (through arrangements made by Marine Products Export Development Authority at subsidised rates) was given twice a day, at dawn and dusk at the rate of 7–10% of body weight. The food requirement was determined by assessing the percentage of stock surviving, by random sampling method and the progress of growth in weight of the prawns. The food was kept in trays at intervals of every 10 m at the bottom of the pond a little away from the bunds. Broadcasting the feed was avoided in order to avoid wastage. Because of the delay in getting the pelletized food from the company, supplementary feed consisting of fish meal, shrimp head, rice bran, ground nut oil cake, tapioca and minerals was given during June–July, 1986. Predatory birds were kept away by firing crackers and by keeping 'scare-crow.'

Growth assessment

The progress of growth of prawns was assessed by taking fortnightly random samples with castnet at different points of the pond and the results are presented in Table 3. Based on the actual observations made, an estimated average growth rate of the stock from all four ponds are tabulated for comparison. During the first month the rate of growth was more or less the same in all ponds. The overall growth rate varied from 13.6 mm (1.4 g) to 15 mm (1.7 g) depending upon the period of culture in different ponds (Table 1). The

maximum gain in weight was seen with prawn stocked in pond 1. Prawn seed of average 22 mm released on 1–3–1986 have grown to 123.5 mm (13.2 g) in the course of 224 days, whereas the stock in pond 2 attained a size of only 116 mm (11 g), and it had taken more number of days. The rate of growth was affected during May–June, 1986 when the supply of pelleted feed was interrupted. In ponds 3 and 4, the stock reached a size of 106–108 mm with an average weight of 8 g in the course of 5 1/2 months. The rate of growth was generally poor when compared to earlier experiments carried out in the same environment with lower stocking density. It may be mentioned that the earlier crop during August, 1985 – January, 1986, took only five months to attain the size of 138 mm (19.8 g) because of the conducive hydrological factors and optimum stocking density at 44,000/ha (Marichamy, 1986).

Harvest and production

Harvest arrangements were made after ascertaining the quotations of competitive price from buyers on the basis of samples given. The slope of the pond bottom and trenches facilitated quick draining through outlets during night hours. Harvesting was made easy by spreading a net exactly on the floor of the catching pit (area 15 m x 15 m) before draining commenced. As the water receded, bulk of the prawns assembled in this limited water area and were harvested by lifting the net from four sides. The rest of the stock was collected by using a cast net and finally by hand picking after expelling the remaining water with a small pump. Harvesting operations were over before 1000 hours and the time factor was considered important to avoid spoilage of the prawns as water temperature increased towards noon.

In ponds 3 and 4, prawns started swimming near the surface in distress due to oxygen deficiency, particularly in the early morning hours and instances of stray mortality were noticed in September, 1986. Prawns were harvested from these ponds on 13–9–1986. The production details are given in Table 1. 805 kg of prawns with an average size of 106 mm (8 g)at survival rate of 74.5% were harvested from pond 3 and 330 kg from pond 4. The rate of production was more or less the same, being 881 kg/ha/172 days in pond 3 and 897 kg/ha/166 days in pond 4. The actual production in pond 2 (0.95 ha) was 1,169 kg and the rate of production amounted to 1,234 kg/ha/232 days. Better production was attained from pond 1 as the rate of growth was comparatively good with high rate of survival (95.4%). The rate of production was 1,604 kg/ha/224 days. No predators were noticed in ponds 3 and 4 and the low survival cannot be ascribed to this problem. Two or three fish, *Lates calcarifer* and *Elops* were noticed in the catches made from pond 2. *Nematalosa nasus* occurred in large numbers (40 kg) in this pond; though it is not a predator, it was a competitor for food and space.

Fig. 2. Part of the harvested prawns.

Marketing and economic aspects

The Century Cold Storage Ltd., Palayakayal a leading shrimp exporter offered the best price for the cultured prawns. The catches were disposed off on the spot. Prawns from pond 1 fetched better price of Rs. 46.25/kg (head-on count 76/kg). The rate for prawns from pond 2 was Rs. 36.75/kg since the head-on count was 91/kg. The catches from the last two ponds were sold at Rs. 22.00/kg as the count was 123/kg. The total yield of 2,930 kg of prawns produced from four ponds of 2.75 ha was sold for Rs. 1,00,537. This works

Fig. 3. The catch being weighed for disposal.

out to the average income of Rs. 36,558 per ha/7 months. The cost of fixing of sluice pipes, and the recurring expenditure such as wages for watchman, cost of supplementary food, fertilizers, fuel and energy, preparation of pond by tilling, harvesting and marketing and miscellaneous expenditure came approximately to 50–60% of the income. The capital expenditure involved in the construction works and installation of pump sets can be recovered in four crops at the rate of 25% of the profit. The income can be substantially increased by proper management, particularly by curtailing the expenditure on excess feeding which has happened in the present experiment.

General remarks

The occurrence of seed of *P. indicus* in two seasons in a year during February–May and August–December facilitates designing the culture programme accordingly. Out of the two crops raised in a year, the summer crop from February/March onwards was continued upto August/September covering a maximum of six to seven months and the next crop started from September onwards could be limited to four to five months, because of the prevalence of conducive environmental factors. Maintenance of phytoplankton bloom in the rearing ponds by manuring the water, forms an important aspect in prawn culture. Culturists in Japan endeavour to grow phytoplankton in ponds particularly in summer when the prawns grow at a fast rate (Shigueno, 1972). Since the growth and production of prawns in the pond vary according to the level of primary production, the productivity was maintained at moderate levels of 500–1,000 mg C/m^3 / day in culture ponds.

Suseelan (1975) estimated the average growth attainment upto 135 mm (24.7 mm/month in the summer crop and 19–21 mm in the later monsoon) for crops raised in salt pan area of Manakkudy, where the salinity varied from 10.55 to 28.10 ppt only. Sultan *et al.* (1973) indicated an average growth rate of 25.8 mm/ month eventhough the culture area was brackishwater. In the preliminary experiments carried out in the present environment, Marichamy (1986) observed a better rate of growth of 21.6 mm (3.8 g) / month in the monsoon crop raised during August, 1985–January, 1986 when the salinity was recorded around 35 ppt during most of the days. The growth rate in the present summer crop was in the range of 13.6 mm (1.7 g) to 15 mm (1.5 g) / month, because of the prevalence of high salinity around 45 ppt in most of the days. Muthu (1980) observed the ideal salinity range for the culture of *P. indicus* as 10–35 ppt.

High stocking density may be another factor affecting the growth rate as seen in the present experiment. The growth rate in ponds 3 and 4 was extremely low because of the maximum stocking rate of 1.5 lakh/ha whereas the earlier experiment made in the same season with the stocking density of 80,000/ha revealed better growth rate. The influence of the stocking density on the growth rate has been studied earlier. Mohamed *et al.* (1980) recorded a high growth rate of 1.0–1.1 mm/day till the size of 125 mm in *P. indicus* in a similar environment with low stocking rate of 27,000/ha. Venkatesan *et al.* (1982) reported the maximum growth and production of *P. monodon* at a stocking density of 25,000/ha even in brackishwater ponds and considerably low values when the density was increased to 40,000/ha. Sriraman and Ananthanarayanan (1986) opined that the ideal stocking density was 30,000 to 45,000/ha for good production of *P. indicus*. Based on the two sets of experiments covered so far in the salt pan areas of Veppalodai, it may be stated that 50,000–70,000/ha would be the optimum stocking density as per the productivity of the ponds. The depth of water as well as the rate of exchange in rearing ponds play a key role in the ecological conditions to promote the growth and survival rates. The poor results observed in the last two ponds may be attributed also to the low depth of water and inadequate water exchange. The rate of production in the present experiment was comparatively better than the results published from different areas. The recent experiments on *P. monodon* carried out in Pulicat Lake gave maximum production of 1,157 kg/ha/crop (Sanjeeva Raj, Keynote address in Nat. Symp. Estuarine Biology, Parangipettai, October, 1986). Suseelan (1975) recorded a maximum production of 1,134 kg/ha/year. The maximum production of 1,200–1,600 kg/ha/crop obtained in the present work appears to be the best so far reported under such conditions. The present efforts in the salt pan area have shown that the project is a profitable venture.

Eventhough the hydrological conditions are not so conducive in the present experiments, the results have shown that farming can be organised for still better yields by resorting to management practices particularly

by limiting the stocking density to about 70,000/ha. Improvements in flushing system, increase in the water depth, steady supply of nutritive food, provision of 'water blender' to avoid oxygen depletion are some of the suggestions for more effective implementation and higher production. The peak summer period may be avoided for stocking and the duration of culture can also be reduced to realise a better economic return from the yield.

In Japan 70 percent of the prawn ponds are converted salt pans. About 1,20,000 ha of brackishwaters in the form of disused salt pans and low lying coastal areas are available for culture purposes in Tamil Nadu. The Government of India has already cleared a project for the development of 150 ha of brackishwater area for farming in Thondikadu in Tanjore District, Valinokkam in Ramanathapuram District and Pinnakayal in Tirunelveli District or in Pulicat Lake (Dixitulu, 1986). Realising their commercial value, a number of private farmers have just started prawn culture practices in salt pan areas in Palayakayal, Pinnakayal, Vaipar and Vembar. With the available technology in prawn farming, the salt pan areas can be profitably utilised for prawn culture in the near future.

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DISTRIBUTION, HABITS AND HABITATS OF PALINURID LOBSTERS AND THEIR LARVAE

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Introduction

The lobster fishery has assumed considerable economic importance in the last few years and consequently there has an increased effort in several parts of the world to study and understand the various aspects of the species that constitute the fishery. Under the popular name 'lobsters' four families have been recognised. They are the clawed lobsters belonging to the family Nephropsidae, amongst which *Homarus gammarus* the European lobster, *H. americanus* the American lobster and *Nephrops norvegicus* the Norwegian lobster are the well-known ones. The other three families are closely related and they are the Synaidae (the coral lobsters) with a single genus *Palinurellus*, the Scyllaridae (the slipper lobsters) with several genera and the spiny lobsters - Palinuridae. Both the clawed lobsters and the spiny lobsters are of commercial importance.

The spiny lobsters or Palinuridae are widely distributed throughout tropical and sub-tropical seas and

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a few species occur in temperate waters also. The Family Palinuridae consists of nine genera and all these are represented in the Indian Ocean. Altogether eighteen species belonging to 9 genera have been recorded from the Indian Ocean. Of these, seven species *viz., Panulirus homarus, P. ornatus, P. versicolor, P. polyphagus, P. penicillatus, P. longipes* and *Puerulus sewelli* are common in the Indian waters. *P. sewelli* is known to occur in commercially exploitable quantities in the deeper waters especially off the coast of Kerala. The results of recent exploratory fishing conducted by the Integrated Fisheries Project have indicated the occurrence of large quantities of *Palinustus mossambicus* also in the deeper waters of the southwest coast of Kerala. The commercial possibilities of exploiting this species are, however, not known. This makes eight species of palinurids of commercial importance. Amongst the six species of Panulirus, all of which are inhabitants of shallow waters especially rocky areas or where there are extensive coral reefs which offer suitable retreats, only four species form the mainstay of the commercial fishery. These are *P. homarus, P.polyphagus, P.ornatus* and *P.versicolor* and details of the distribution of which are given together with the distribution of *Puerulus sewelli* and *Palinustus mossambicus* with the description of species at the end.

Habits and habitat

Habits

Spiny lobsters are shelter dwellers and include singular or multiple den residency and show definite homing patterns. Most of the species do not undertake extensive migrations. They are nocturnal foragers and generally begin to feed at dusk, are gregarious and return to their dens before dawn. According to Kanciruk (1980) "Interactions between environment (temperature, light, photoperiod, salinity *etc.*) and palinurid behaviour are complex, and evidence indicates that such environmental parameters strongly affect activity patterns, migratory movements, reproduction, growth and regional and local distribution. Based on current research, the most important of these factors seems to be light (controlling activity patterns) and temperature (influencing or triggering migratory behaviour and breeding activity)."

Habitat

Although these lobsters enjoy wide distribution, there are clear evidences to show that most species prefer particular regions or habitat. There is a great variation in the habitat preference of adult lobsters and it may vary from the intertidal zone to great depths of the ocean characterised by mud-ooze substrate and perpetual darkness. It is generally believed that the adult lobsters do not undertake long migrations. Studies carried out by Mohamed and George (1967) on the migration of *P. homarus* showed extremely limited movements. It is, however, reported that *P. ornatus* undergoes mass migration between habitats which explains the significant contrast between the habitats of the juveniles and adults of this species. "The most characteristic feature of the habitat of many of the palinurids is the residence area or den. Dens are not usually constructed by the Palinuridae but are opportunistically chosen from the surrounding habitat. The burrowing ability of most Palinuridae is usually assumed to be minimal." Except in a few regions, detailed studies on the habitat preferences of lobsters have not been carried out. Some of these studies have indicated that there are 'true home dens' to which individual lobsters will repeatedly return after their nocturnal foraging. The available information has been compiled by Kanciruk (1980). In regard to the four species, which contribute mainly to the lobster fishery of India, Prem Kumar and Daniel (1975) have given a detailed account of their distribution pattern in the Indian region.

P. ornatus: It occurs in appreciable quantities along the southeast coast of India where they constitute a good fishery. The species has been recorded from other regions also along the coast of India.

P. polyphagus: This species although recorded from both the coasts of India, is more common along the west coast particularly the northwest coast of India forming a good fishery. Chopra (1939) has, however, stated that this is the only species of lobster of commercial importance off Calcutta.

P. versicolor: Although this species also enjoys a fairly wide distribution along the coasts of India and the Andaman and Nicobar islands, it does not contribute significantly to the fishery and is the rarest commercial species.

P. homarus: Amongst the four species which contribute to the commercial fishery, this is the most important and forms a good fishery in several places along the coasts of India and the Andaman and Nicobar Islands. The bulk of the fishery is concentrated along the southwest coast of India. Berry (1971) has observed that along the East African coast *P. homarus rubellus* inhabits the surf zone and is most tolerant to surge and

turbulence. He also reported that the distribution is correlated to the occurrence of its main food which is the mussel *Perna perna*. It is interesting to mention here that large-scale settlement of the puerulus stage of *P. homarus* was noticed in the spat collectors kept off the coast of Kovalam (near Madras) for collecting the spat of *Perna viridis*. This may indicate that in this region also mussels constitute the main food of the puerulus as well as the adults of *P. homarus*.

Puerulus sewelli: This is known to occur in commercially harvestable quantities in the deeper waters off Kerala. So far no attempt has been made to fish them on a commercial basis.

Larval history

The eggs are attached to the endopodites of the pleopods of the female and no reliable information is available on the time taken for development and hatching of the larvae. In most cases hatching takes place at night. Generally the first larval stage is recognized as the phyllosoma. Some authors have, however, recorded stages earlier to the phyllosoma stage and these have been referred to as 'prenaupliosoma', 'naupliosoma' or 'prephyllosoma.' These, whenever present, last only for a few hours before moulting into the phyllosoma. Therefore, some believe that the "prenaupliosoma stage probably represents an embryonic form occurring as a result of premature rupturing of the eggs in most species, although the finding of prenaupliosoma of *P. argus* in the plankton by Sims (1965) shows this is not universal" (Phillips and Sastry, 1980). In regard to the species occurring in Indian waters the only record of a free larval stage prior to phyllosoma is that of Deshmukh (1968) who observed in *P. dasypus (= homarus)* a larval form different from the naupliosoma and phyllosoma and suggested the name 'prephyllosoma.'

Phyllosoma larvae, as the name indicates have flat and leaf-like body. They are transparent, have long legs and protuberant eyes and have orange-red chromatophores particularly on the coxal segments of the pereopods and between the base of the first and second antennae. The first stage of phyllosoma (Fig. 1) measures from 1.1 to 2.3 mm in body length (from the tip of the abdomen to the tip of the forebody between the eyes) depending on the species. The eyes are thick stalked but unsegmented and are about as long as the first antenna. The first antenna is about one and a half times the length of the second antenna and both are unsegmented. The first maxilliped may be present or absent and the second maxilliped is segmented. The third maxilliped is biramous with setose exopodite. There are three pereopods of which the first two are biramous with setose exopodites. The abdomen is

Fig. 1. First stage phyllosoma larva of *Panulirus homarus* (Linn.) (Photo courtesy: Mr. M. Kathirvel).

unsegmented. The shape of the cephalic shield varies from species to species. Differences have been observed by many workers between the larvae reared in the laboratory and those obtained from plankton.

The specific identification of the phyllosoma larvae has been a major problem especially in regions where there are several species of lobsters co-existing. The identification in most cases therefore, has been based on circumstantial evidence relating to the intensity of larval population and the abundance of particular species. Positive species identification is possible either through laboratory hatched larvae or from the last stage of phyllosoma metamorphosed into the puerulus stage

Fig. 2. A group of advanced phyllosoma larvae of *Scyllarus* sp. (Photo courtesy: Mr. M. Kathirvel).

in the laboratory whose specific identity could be determined. Out of the different species of lobsters recorded from the Indian Ocean, the first phyllosoma of only six *viz., P. homarus, P. ornatus, P. polyphagus, P. longipes, P. japonicus* and *Puerulus sewelli* are correctly known. These are based on laboratory hatched larvae. Rearing of these larvae in the laboratory through successive stages has met with relatively little success. The phyllosomas pass through a series of moults and with each moult the larvae increase in size. Each moult, however, does not necessarily mean that there is a concurrent change in the stage of development because laboratory experiments have shown that there may be several moults between successive stages. Different workers have assigned varying number of stages through which the phyllosoma larvae pass from the newly hatched to the time they metamorphose into the puerulus stage when they start assuming some of the characters of the adults. At this stage they generally change from a planktonic to a settled life and moults into the juvenile stage and assume the morphological features of the adults.

It is believed that in the case of the Indian species there are about 10 or 12 stages of phyllosoma and that the larval life in different species ranges from 3 to about 6 or 7 months. Depending on the species, the last phyllosoma stage varies in length between 30 and 43 mm. In the final stage all the pereopods are fully developed, the pleopods have become biramous and so also the uropod is fully developed. This last stage of phyllosoma metamorphoses into the puerulus and Gurney (1942) describes this as "the most profound transformation at a single moult known among Decapoda."

Distribution and abundance of phyllosoma larvae

Distribution

The distribution of phyllosoma is determined by several factors particularly in view of its prolonged larval life and the influence excerted by the prevailing water movements. Most of the studies, however, have shown a greater concentration of phyllosoma along the coast or near islands. This is to be expected owing to the fact that majority of the species of adult lobsters inhabit coastal regions, around islands and coral reefs. It is also generally believed that these larvae are seldom found beyond the geographical limits of the adult populations. In spite of extended planktonic life, during which period they are subjected to varying influence of water movements, it is interesting that the larvae still remain concentrated in certain restricted areas thereby facilitating the restocking of these regions. Tampi and George (1975) while studying the International Indian Ocean Expedition collections have remarked that "one of the strange features worthy of notice is the lack of larval specimens in any appreciable numbers along the coastal regions of India and Ceylon. While adults of the palinurids are present in large numbers around Ceylon, southwest and southeast coasts of India contributing to commercial fishery (De Bruin, 1960; 1962; George, 1968), the absence of larvae from this region in the collections covering a period of 5 years excepting for a single specimen from the Lakshadweep area is quite intriguing." Attempts have been made to study the mechanisms of larval transport and dispersal, and different explanations have been given for the peculiar features of distribution, but still these are not fully understood. The problem has to be viewed from the methods of collection, time and area of sampling and more detailed analysis of the larval transport in relation to the hydrological factors of the regions particularly the water movements are required. Phillips and Sastry (1980) have stated that "The overall direction of the phyllosoma larvae during the larval movements seems to be fortuitous, and there is no suggestion that the larvae actually seek to travel in a particular direction. Under this assumption the presence of larvae in a water mass has been used by oceanographers as indications of the origins of that particular water mass (Murano, 1957; Johnson and Brinton, 1963). Larvae released in shallow inshore areas are typically described as being carried offshore in the particular watermass in which they are released. Thus, while the mechanisms of the return of the larvae back to the coast are not fully understood, their return can be taken as indicating the presence of water movements. The data on the early phyllosoma larvae of *P. cygnus* show that these larvae are transported offshore by the action of surface wind drift, passing over the top and moving contrary to the direction of the described major circulation of the area. This suggests that caution should be used in the interpretation of the movements of the larvae in relation to water circulation features, although the basic truth of the statement is unchanged." Phillips (1981) has, however, remarked in the case of phyllosomas of *P. cygnus* that most of them complete their planktonic period without re-entering the continental shelf waters and that concentrations of the late stage of the larvae have been found in the waters near the edge of the continental shelf.

It is believed by some investigators that the larvae which are carried farthest from the coast and which cannot return to the same area and consequently considered lost may be the source of recruitment to other

areas. This has been observed in the South Florida waters, Australia-New Zealand region and the Madagascar-Southeast Africa region. The ability of the phyllosoma larvae to postpone their metamorphosis into the puerulus stage until they are in the neighbourhood of a suitable benthic habitat has also been mentioned in the literature as a possibility. This may be an inbuilt control mechanism for self preservation.

In the pattern of vertical distribution these larvae show some interesting features. The larvae collected from the Indian Ocean by the DANA Expedition which constitute numerically the best collection, show the quantitative vertical distribution of these larvae. Contrary to the expectations, the maximum number of larvae is found at about 50 m with very few near the surface. They were fairly abundant at 100 m. Their number decreased with increasing depth although fairly large numbers were obtained at 200, 300, 500 and 600 m. The occurrence of the I stage phyllosoma of *P. ornatus* at 2,000 m is difficult to explain and that of IX and XII stages of *P. penicillatus* as far down as 3,500 m is rather interesting. With the available data it is not possible to explain precisely the vertical distribution pattern and the factors influencing this. In general, it could be stated that the majority of the larvae obtained from deeper waters were fairly advanced stages. The study of the oceanographical conditions suggests that the greater concentration of the larvae in the upper 100 m is closely related to the distribution of the pycnocline which acts as an effective barrier for the vertical movements of the larvae. It is also known that intensity of light plays a vital role in the vertical distribution of these larvae, the early stages of which are reported to show a strong photopositive reaction to dim light. In the case of the phyllosoma larvae of *P. cygnus* recent investigations have shown that they perform daily diurnal migrations, rising to the surface at night and descending to lower depths during day time. Therefore, light appears to be an important factor in influencing the vertical distribution.

Abundance

In spite of increasing attention being paid to the study of the phyllosoma larvae, no serious attempt seems to have been made to study the abundance and quantitative distribution of these larvae. A large number of species of adults have been recorded from Indian waters but the paucity of their larvae in the regular plankton collections made even in regions where the adults are known to inhabit is somewhat puzzling. This could partly be attributed to the type of net used, method and time of collection. Ritz (1972) observed that the densities of the early stages of phyllosoma of *P. cygnus* are apparently independent of the plankton biomass but in the case of late stages a correlation between the larval density and the plankton biomass was noticed. Tampi (1973), however, reported that generally "the areas of poor phyllosoma catch coincide with regions of low zooplankton biomass and especially the decapod larvae."

The richest collection of panulirid phyllosomas from the Indian Ocean appears to be the one made by the DANA Expedition during 1928–1930 and described by Prasad, Tampi and George (1975). The larvae have been assigned to 10 species belonging to 4 genera, whereas adults of 10 species belonging to 3 genera have been recorded from Indian waters. It is interesting to note that in the DANA collections as well as the International Indian Ocean Expedition collections studied by Tampi and George (1975) the maximum number of larvae was that of *P. versicolor* although this species does not contribute substantially to the commercial fishery along the Indian coast.

Despite the considerable amount of information that has been gathered on the distribution of the adult lobsters and many workers have been studying the larval history, much more remains to be done to have a complete picture of the life history of this group of crustaceans which have great economic value. Specific identity of the larval stages of most of the species is unknown, the distribution pattern in space and time and the effects of environmental factors on this, their mortality rates and number of stages through which the larval phase is completed, their food and feeding habits and conditions necessary for the phyllosomas to metamorphose into the puerulus stage thereby changing from a planktonic to a benthic life are some of the aspects which require detailed study. It would also be interesting to conduct some experiments to find out whether the normal lengthy larval period could be abridged so that when a complete culture system is evolved considerable time could be saved in producing marketable size lobsters. These data together with the information on the ecology and biology of the adults are essential for the management of this valuable resource.

Description of the species

The following is a brief description of the important distinguishing characters of the different species of palinurids occurring in the Indian waters.

Panulirus homarus* (Linnaeus)

Synonyms
Locusta marina Rumphius
Locusta marina indica Rumphius
Cancer homarus Linnaeus
Astacus homarus Fabricius
Palinurus homarus Fabricius
Palinurus burgeri De Haan
Palinurus (Panulirus) dasypus Heller
Palinurus femoristiga De Man
Panulirus burgeri Bouvier

The antennular plate has four principal spines, the anterior pair being larger than the posterior. In between them there is a group of spinules. The median and lateral spines of the fused coxicerites of the antennae are small and placed almost in a line. One to three spinules may be present in between the median and lateral spines. The exopod of the second maxilliped is with or without a flagellum which if present may vary in its number of segments. The third maxilliped is without an exopod. The abdominal somites have an interrupted or uninterrupted transverse groove, the anterior margin of which is crenulated and with setae.

The colouration is generally bluish grey with numerous minute white dots. A row of six or seven large white spots are present on either side of the carapace. Each abdominal somite has a conspicuous white spot on either side and the walking legs have irregular yellowish-white spots.

Panulirus ornatus* (Fabricius)

Synonyms
Cancer (Astacus) homarus Herbst
Palinurus ornatus Fabricius
Palinurus sulcatus H. Milne Edwards
Panulirus sulcatus White
Panulirus ornatus Stimpson
Palinurus (Senex) brevipes Pfeffer
Palinurus (Senex) sulcatus Pfeffer
Palinurus homarus Pfeffer
Panulirus polyphagus Borradaile

Four principal spines, the anterior pair being larger than the posterior, are present on the antennular plate. Small spinules may be present in between the two pairs of spines. The median spine of the fused coxicerites of the antennae is larger than the lateral spine and the three spines are situated almost on the same line. There are no spinules. The second maxilliped has an exopod without a flagellum but with a tuft of setae, whereas the third maxilliped is without an exopod. Abdominal somites without a transverse groove.

Bluish green in colour, the carapace has pale cream verniculate lines and bright orange spots. Each abdominal somite has a dark blue transverse band with one or two cream coloured oblique spots on the sides. Walking legs alternately banded or marbled with cream and maroon.

Panulirus penicillatus* (Olivier)

Synonyms
Astacus penicillatus Olivier
Palinurus penicillatus Olivier
Panulirus penicillatus White

The antennular plate has four principal spines united at the base, the anterior pair being smaller than the posterior. Rest of the antennular plate is unarmed. The median spine of the fused coxicerites of the antennae is larger than the lateral spines and there are one or two spinules in between the median and lateral spines. The second maxilliped has an exopod with many jointed flagellum while the exopod of the third maxilliped is without a flagellum. The abdominal somites have an uninterrupted transverse groove, the anterior margin of which is non-crenulated and without setae.

Dark brownish green or brownish pink in colour with numerous orange yellow spots. The entire abdomen is speckled with minute white spots and on top of the 'plate D' a conspicuous white spot is present. There are pale yellow straight or wavy lines along the length of the walking legs.

Panulirus polyphagus* (Herbst)

Synonyms
Cancer (Astacus) polyphagus Herbst
Palinurus fasciatus Fabricius
Panulirus fasciatus Milne-Edwards
Panulirus polyphagus Nobili

The antennular plate with two principal spines situated far anteriorly and the rest of the plate is unarmed. The median spine of the fused coxicerites of the antennae is large and situated in front of the lateral spines. There are no spinules. The exopod of the second maxilliped has a many jointed flagellum, whereas the third maxilliped is without an exopod. The abdominal somites are without transverse groove.

Greenish grey or muddy brown in colour with numerous indistinct white spots. A row of six large white spots are present on either side of the carapace. There is a large oblique patch on either side of the first abdominal somite. The hind margin of each abdominal somite has a brown band with a white line in the middle. Yellowish white spots are present on the walking legs.

Panulirus versicolor* (Latreille)

Synonyms
Palinurus versicolor Latreille
Palinurus taeniatus Lamark
Palinurus fasciatus Von Siebold
Palinurus (Panulirus) ornatus var. *decoratus* Heller
Panulirus dasypus Ortmann
Panulirus demani Borradaile
Puer spiniger Bouvier
Puerulus spiniger Calman
Panulirus versicolor Calman
Panulirus versicolor Borradaile
Palinurus ornatus Rathbun
Panulirus ornatus Rathbun
Palinurus fasciatus Musgrave
Panulirus versicolor De Man

The antennular plate has four principal spines, the anterior pair equal to or larger than the posterior one. Rest of the antennular plate is unarmed. The median and lateral spines of the fused coxicerites of the antennae are large and subequal, the former being in advance of the latter. No spinules are present. The exopod of the second maxilliped has usually a single jointed flagellum. The third maxilliped is without an exopod. The abdominal somites have transverse furrows in the juveniles while these are absent in the adults.

In colouration they are usually bright green with a bluish tinge. The carapace has almost symmetrical dark bluish-black patches and flecks bordered by cream lines. Patches are present at the sides with cream coloured wavy lines inside. Hind margin of each abdominal somite has a dark bluish-black band with a white line in the middle. Walking legs have white lines along their entire length.

Panulirus longipes* (A. Milne Edwards)

Synonyms
Palinurus longipes A. Milne Edwards
Palinurus guttatus Hoffmann
Palinurus (Panilurus) longipes Miers
Palinurus longitarsus Lenz and Richters
Panulirus japonicus Gruve
Panulirus japonicus longipes De Man
Panulirus longipes George and Rao
Panulirus longipes longipes George and Holthuis

The species *longipes* occurring along the Indian coasts is considered to be a distinct sub-species and is called *P. longipes longipes*. The distinguishing characters are that the antennular plate has two principal spines in addition to three to five spinules in front and four to eight behind. The median spine of the fused coxicerites of the antennae is equal to or slightly larger than the lateral ones. There are three to four small spinnules in between the median and lateral spines. The second and the third maxillipeds have a distinct flagellum. The abdominal somites have an interrupted or uninterrupted transverse groove, the anterior margin of which is non-crenulate and with setae.

The colouration varies from dark brown to reddish brown with a violaceous tinge and there are numerous bright and dull white spots. A conspicuous white spot on top of the 'plate D'. A similar spot on either side in addition to a pair on the dorsal side of the abdominal somites II to VI. Walking legs have conspicuous white spots.

Puerulus sewelli Ramadan @

Synonyms
Panulirus angulatus Alcock
Puerulus angulatus Calman

The lateral margins of the carapace are cut into three teeth which decrease in length posteriorly. The posterior tooth is not far in advance of the cervical groove. The infra-orbital spine is large and has below and anterior to it a prominence which is half as long as the spine and cut into two teeth and behind this there are two other teeth. The abdominal somites are carinated, the carina of the sixth segment being double. The second to fifth somites are transversely grooved near the posterior edge. The antennular peduncle is more than half as long as carapace and the basal segment is longer than the second and third joints together. The antennal peduncle is spinose on its outer margin in adult specimens. The external maxillipeds reach the middle of the second segment of the antennular peduncle, its exopodite reaches the middle of the carpus.

* Descriptions of the six species of *Panulirus* have been taken from Nair *et al.* (1973).

@ Description from Ramadan (1938).

Palinustus mossambicus Barnard

Synonym

Palinustus mossambicus Barnard

Carapace prismatic, covered with tubercles which are fringed with stiff setae. The anterior margin of the carapace between the supraorbital processes is straight and provided with 4 to 6 spinules of different size and stronger median spines are absent. Each orbit is fringed by the supraocular process, three forwardly directed strong spines and by some small spinules. Cervical groove distinct and behind this groove a posteriorly converging double row of three or four small spinules are present in the median region of the carapace. The first abdominal segment has an uninterrupted transverse groove which has a row of setae along the anterior margin. The second to fifth abdominal segments are provided with uninterrupted anterior transverse groove and a posterior groove which is interrupted in the middle by a short longitudinal carina. Antennular segments with four spines in the median part anteriorly tapering and the antennal peduncles have about five longitudinal rows of strong spines. All the three maxillipeds have an exopod with a flagellum in the first and second maxillipeds.

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EXPERIMENTS ON THE CULTURE OF *PENAEUS INDICUS* IN POLYETHYLENE FILM-LINED PONDS AT CALICUT*

The possibilities of converting extensive areas of sandy shores into productive aquaculture ponds by providing polyethylene film-lining have been reported by Mohan and Nandakumaran (*Mar. Fish. Infor. Serv., T & E Ser.*, No. **26**: 6-8, 1980 and Proc. Symp. Coastal Aquaculture, **1**: 409-412, 1982) based on the experiments conducted at Calicut by the Central Marine Fisheries Research Institute. Following the above study another set of experiments were conducted from April to September, 1981 with the seeds of the prawn *P. indicus*, produced at the Narakkal Prawn Culture Laboratory of the Institute and transported to Calicut in oxygen filled bags. The average length of the seed was 18 mm. They were stocked in three polyethylene film-lined ponds *viz*., ponds A (192 m^2), B (63 m^2) and C (123 m^2) at stocking densities of 14.6, 38.0 and 30.5 /m^2 respectively on 25–4–1981. Some of the seed were grown separately in a nursery and when they attained an average size of 46.6 mm and 84 mm they were stocked in ponds D and E (70 m^2 each) at densities of 6.4/m^2 and 7.1/m^2 respectively on 12–5–1981 and 23–7–1981.

Sample measurements of length and weight of the stocked prawns were taken once in a fortnight. Environmental parameters such as salinity and dissolved oxygen were estimated weekly and also at the time of taking prawn sample for measurements. Temperature was noted twice daily at 10 A.M. and 3 P.M. Pelleted prawn feed (proximate composition: crude protein 30.68%, lipid 3.40%, ash 22.55%, carbohydrate 41.27% and moisture 2.10%) prepared at the Narakkal Prawn Culture Laboratory of the CMFRI was given as food up to the second week of August at a rate of 10% of the body weight. Afterwards the prawns were fed at the same rate with moist dough made out of equal quantities of wheat powder, coconut oil cake, rice and fish meal, as the feed from the above laboratory was not available for feeding. The stocking details, environmental data and the results obtained are given in Table 1.

Temperature ranged between 27.3° and 35.5°C and the maximum was observed in pond D during May and

Table 1. *Stocking and harvest details of* P. indicus *and the environmental data*

Particulars	Ponds				
	A	B	C	D	E
Area of pond (m^2)	192	63	123	70	70
Date of stocking	25–4–81	25–4–81	25–4–81	12–5–81	23–7–81
Date of harvest	5–9–81	18–8–81	17–8–81	18–7–81	8–9–81
Duration of the experiment (days)	133	115	114	67	47
Mean length at stocking (mm)	18.0	18.0	18.0	46.6	84.0
Mean weight at stocking (g)	0.1	0.1	0.1	0.7	3.6
No. stocked	2,800	2,400	3,750	450	500
Stocking density (no./m^2)	14.6	38.0	30.5	6.4	7.1
No. harvested	535	190	134	390	449
Survival rate (%)	19.1	7.9	3.6	86.7	89.8
Count per kg	160	76	108	100	145
Mean length at harvest (mm)	102.1	124.3	111.8	116.0	100.9
Mean weight at harvest (g)	6.6	13.3	10.1	10.4	6.9
Daily length increment (mm)	0.60	0.92	0.82	1.02	0.35
Daily weight gain (g)	0.05	0.11	0.09	0.14	0.07
Temperature (range in °C)	28.1–34.3	27.3–35.3	28.9–34.3	29.0–35.5	29.2–31.8
Salinity (range in ppt)	1.1–29.4	4.2–25.8	5.8–28.7	6.0–29.3	11.8–31.1
Dissolved oxygen (range in ml/1)	3.0–4.8	4.0–4.8	3.5–5.6	3.2–4.7	3.7–4.7

*Prepared by S. Lazarus & K. Nandakumaran, Calicut Research Centre of CMFRI, Calicut and K. H. Mohamed & M. S. Muthu, CMFRI, Cochin.

the minimum was recorded in pond B in August. In general the temperature was high during April–May period and low during June–August period. Salinity had a high range of fluctuation in the ponds. It varied from 1.1 to 31.1 ppt, and the minimum was observed in pond A and the maximum in pond E. Though salinity in the ponds ranged between 18.3 and 29.3 ppt in April/May except in pond E, it started declining towards the end of May due to the onset of monsoon and reached a low value at the end of June. Dissolved oxygen level varied within a narrow range of 3.0–4.8, 4.0–4.8, 3.5–5.6 , 3.2–4.7 and 3.7–4.7 ml/l in ponds A, B, C, D and E respectively. Normally the low values were observed towards the end of the experiment.

Good growth rate was seen in pond D where the stocking density was 6.4/m² (Fig. 1). The mean size (46.6 mm) of the prawn on stocking was also high when compared with other ponds in which it was 18 mm except pond E in which it was 84.0 mm. Comparatively better results were obtained in pond B and C. In pond B rapid growth was observed upto the 32nd day with an average daily increase of 1.7 mm. Afterwards it was only 0.6 mm per day which was much less than the average for the pond. But weight increment was very slow up to the 17th day and afterwards the increase was steady till the 105th day. In pond C also an almost similar trend was observed except that the weight remained stationary from 75th to 89th day and then increased again. The length increase was rapid during the first 17 days and thereafter it slowed down very gradually. In pond A the overall performance of the prawns was poor when compared to the prawns in the other ponds. The growth rate and weight increment observed were respectively 0.86 mm and 0.47 g per day upto 75th day of the experiment and from 89th to 121st day they were 0.55 mm and 0.1 g. The mean size and mean weight were found to be stationary at 84 mm and 3.6 g respectively from 75th day to 89th day.

The foregoing observations clearly show that stocking density plays an important role in the growth of prawns cultured in the polyethylene film-lined ponds. In pond D where the stocking density was less, the growth was

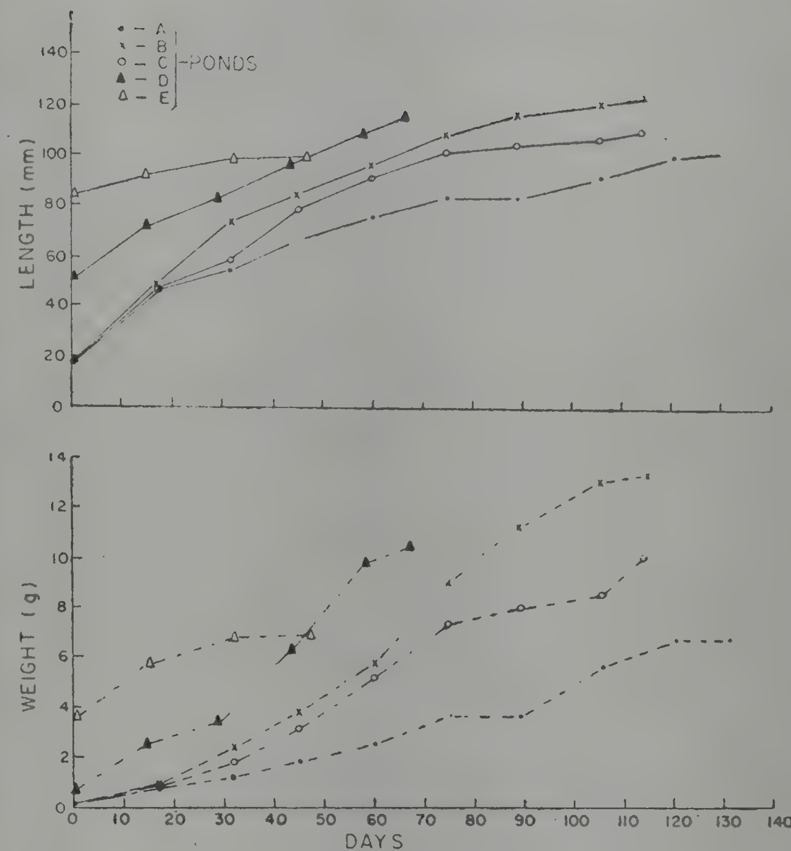


Fig. 1. Growth of *P. indicus* in the different ponds.

observed to be very good. The fast growth rate found in pond B and C may be due to high initial mortality of the fry soon after their stocking thereby thinning the population. This is further evidenced by the low survival rate and better size of the prawns at harvest observed in these two ponds.

The above experiments also show that the size at stocking has a bearing on the survival rate of the prawns. In ponds A, B and C the prawns were stocked at a smaller size (18 mm) and the survival rates were respectively 18.4%, 7.9% and 3.6%. But in pond E the stocking size was 46.6 mm and in pond D it was 84.0 mm and the survival rates were respectively 86.7% and 89.8%. The greater survival rates in ponds E and D could also be due to the shorter duration of the experiment in these ponds, where the prawns were reared for only 67 and 47 days respectively. In ponds A, B and C the prawns were kept for more than 100 days. Along with good survival rates, ponds D and E yielded good harvests (Table 1).

SOME RECENT OBSERVATIONS ON SMALL-SCALE FISHERY IN THE VICINITY OF MADRAS*

Madras zone is one of the important fishing centres on the east coast of India. The city has several landing centres, from where different types of indigenous gears are being operated in addition to trawls and gill nets by mechanised vessels. To understand the fish landings from different gears in Madras, three landing centres, *viz.*, Kasimedu, Triplicane and Nochikuppam were selected. Kasimedu is about 8 km north of Triplicane and Nochikuppam is about 2 km south of Triplicane. Though these centres are nearer to each other, they were selected because of the variety of indigenous gears operated from these centres. Kasimedu supports mechanised fishing also but the present data relate only to the indigenous catch.

Data collected on indigenous gears for a four year period from 1980 to 1983 were analysed and presented in this account. Biweekly observations were made on catch, effort and catch composition of each gear separately for the three landing centres from 6 A.M. to 6 P.M. and the data collected were weighted for the month. Indigenous gear landings occur only during day time in these centres. Principally, two types of bag net ('Eda valai' and 'Madha valai'), three types of gill net ('Kavala valai', 'Ara valai' and 'Irukka valai'), hooks & line, boat seine ('Thuri valai') and shore seine are operated in the three landing centres. In addition to these eight gears, three more gears ('Retta aruppa valai', 'Thatta kavala valai' and 'Kolamaram') are operated but they are not considered in this account since these gears are operated rarely and the catch from these gears formed only about 0.1% of the total catch.

Table 1. *Gearwise estimated average annual effort (number of units), catch (tonnes), and CPUE (kg/unit) in three landing centres in Madras for the years* 1980–'83

Gear		Kasimedu	Triplicane	Nochikuppam	Total
'Eda valai'	Effort	1,306	381	...	1,687
(Bag net)	Catch	152.2	20.7	...	172.9
	CPUE	116.6	54.4	...	102.5
'Madha valai'	Effort	46	231	90	367
(Bag net)	Catch	3.5	9.6	9.4	22.5
	CPUE	76.5	41.4	104.9	61.4
'Kavala valai'	Effort	973	473	6,894	8,340
(Gill net)	Catch	23.7	13.5	232.9	270.2
	CPUE	24.4	28.5	33.8	32.4
'Ara valai'	Effort	423	2,165	2,023	4,611
(Gill net)	Catch	3.8	19.4	18.6	41.7
	CPUE	8.9	9.0	9.2	9.1
'Irukka valai'	Effort	2	...	547	549
(Gill net)	Catch	0.1	...	16.0	16.0
	CPUE	50.0	...	29.2	29.2
Hooks & line	Effort	1,179	15	1,039	2,233
	Catch	45.2	0.4	9.3	54.9
	CPUE	38.3	26.7	8.9	24.6
'Thuri valai'	Effort	71	2,317	...	2,388
(Boat seine)	Catch	1.1	21.9	...	23.0
	CPUE	15.3	9.4	...	9.6
Shore seine	Effort	...	258	176	434
	Catch	...	5.2	9.3	14.5
	CPUE	...	20.2	52.9	33.5
	TOTAL	229.6	90.7	295.5	615.7

*Prepared by E. Vivekanandan, S. K. Balakumar and R. Soundararajan. Basic data collected by S. Chandrasekar, P. Thirumilu, S. Mohan, T. Dhandapani and S. K. Balakumar, Madras Research Centre of CMFRI, Madras.

Table 2. *Percentage contribution of important fish groups (data based on average annual landings by the indigenous gears) in the three landing centres in Madras for the years* 1980–'83

Groups	'Eda valai'	'Madha valai'	'Kavala valai'	'Ara valai'	'Irukka valai'	Hooks & line	'Thuri valai'	Shore seine	Annual average (t)	% in total catch
Lesser sardines	8.9	0.2	88.9	0.1	...	...	...	1.9	250.3	40.7
Hilsa	99.7	0.3	...	...	...	...	...	...	64.9	10.5
Caranx	3.5	23.9	10.5	19.4	5.2	32.7	1.7	3.2	42.5	6.9
Mackerel	53.8	5.5	9.2	27.2	...	...	...	4.2	33.5	5.4
Ilisha	100.0	...	...	...	...	...	...	...	32.0	5.2
Thryssa	3.5	...	74.7	13.7	...	...	7.1	0.8	20.1	3.3
Sharks	...	...	...	...	10.7	89.3	...	...	19.5	3.2
Scomberomorus	...	...	...	17.8	25.9	54.7	...	1.3	17.2	2.8
Dussumieria	...	...	100.0	...	...	...	...	...	17.2	2.8
Mullet	97.5	1.9	...	...	...	...	...	0.6	17.1	2.8
Silverbellies	12.9	5.0	19.4	27.4	...	...	23.2	12.1	10.6	1.7
Decapterus	...	99.0	...	...	...	...	...	1.0	7.9	1.3
Trichiurus	...	...	...	...	...	...	100.0	...	7.7	1.3
Prawn	62.9	...	3.0	11.9	1.4	...	19.7	1.1	7.2	1.2
Miscellaneous	12.7	2.8	8.7	16.2	10.3	26.9	13.2	9.0	68.0	11.0
TOTAL	28.1	3.7	43.9	6.8	2.6	8.9	3.7	2.4	615.7	100.0

The annual average catch from the eight gears in the three landing centres was 615.7 tonnes (Table 1). 'Kavala valai' and 'Eda valai' contributed 43.9% and 28.1% of the total catch, respectively. Maximum effort was employed in 'Kavala valai' (8,340 units/year) and 'Ara valai' (4,611 units/year) but the maximum catch per unit effort was realised from the bag nets, *viz.*, 'Eda valai' (102.5 kg/unit) and 'Madha valai' (61.4 kg/unit).

In the three landing centres, lesser sardines constituted 40.7% of the annual average landings of 615.7 tonnes. About 89% of the sardine catch was realised from 'Kavala valai' (Table 2), which is a specialised net for catching the sardines. Hilsa, which formed 10.5% of the total catch was landed exclusively from the bag nets. Large fishes like sharks and seerfish were landed mainly by Hooks & lines and 'Irukka valai' (which has a larger mesh size than the other gill nets). Prawns, which formed 1.2% of the total catch, were landed by most of the eight gears, with major contribution (about 63%) from 'Eda valai.'

The traditional gears operating in Madras concentrate mainly on pelagic and mid-water fishes, as evidenced in this study. At present nearly 400 trawlers operate demersal trawl net off Madras and land about 6,200 tonnes every year. The major catch components from the demersal trawls of this area are silver bellies, threadfin breams, sciaenids, lizardfish, prawns, squids and cuttlefish. These groups are landed in a meagre quantity by the traditional gears, thus maintaining compatability between mechanised and non-mechanised gears in the exploitation of fishery resources off Madras.

SOME OBSERVATIONS ON MARINE TURTLES LANDED ALONG MAHARASHTRA COAST *

There have been instances of landing of marine turtles along the Maharashtra coast. The landing of three out of the five species of turtles found in the Indian seas is reported here. Of these species, the leathery or leatherback turtle *(Dermochelys coriacea)* locally known as 'Kuruma kasav' (Fig. 1) is the rarest and the largest while the other two namely olive ridley *(Lepidochelys olivacea)* (Fig. 2) and green turtle *(Chelonia mydas)* locally known as 'Kasav' and 'Hirwa kasav' respectively are relatively common. All were taken as incidental catches in the fishing net. The following are the salient measurements and other details of the turtles landed at different places along the Maharashtra coast during 1984–'85 period (Table 1).

Fig. 1. Latero-dorsal view of the leatherback turtle, washed ashore at Devbag (Near Malwan), Maharashtra coast.

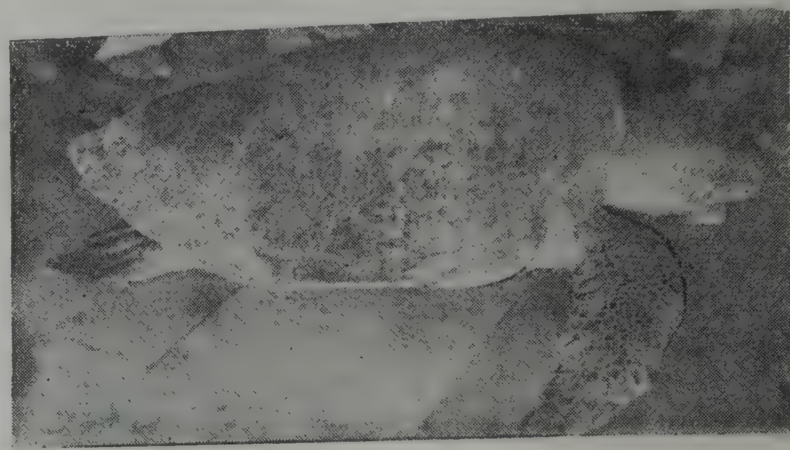


Fig. 2. Dorso-lateral view of olive ridley landed at Vasai, Thane District.

Table 1. *Catch particulars and morphometric data of marine turtles landed along Maharashtra coast*

	Leathery turtle	Olive ridley		Green turtle	
Particulars	Dev Bag (Sindudung Dist.)	New Ferry Wharf (Greater Bombay)	Vasai (Thane Dist.)	Pawas (Ratnagiri Dist.)	Vasai (Thane Dist.)
Date of landing	5–4–1985	1–4–1984	18–9–1984	30–12–1985	19–4–1984
Type of gear	Bottom set gill net	Trawl net	Bag net	Trawl net	Bag net
Type of craft	...	Trawler	Mechanised 'dol' netter	Trawler	Mechanised 'dol' netter
Depth of fishing (m)	...	35	42	36	35
Length of carapace (cm)	149.8	63.0	75.0	51.2	66.5
Width of carapace (cm)	109.0	60.0	59.0	44.0	56.8
Length of plastron (cm)	142.5	50.5	52.0	...	51.2
Width of plastron (cm)	72.5	48.0	49.1	...	47.2
Width of head (cm)	28.9	...	...	...	...
Length of anterior flipper (cm)	105.2	...	...	...	...
Length of posterior flipper (cm)	72.1	...	...	...	...
Sex	Male	Male	Female	Male	Female
Total weight (kg)	100.0	48.0	54.5	38.0	42.8

*Prepared by J. P. Karbhari, A. Prosper, C. J. Josekutty and J. R. Dias. Bombay Research Centre of CMFRI, Bombay

It was learnt that the leatherback turtle washed ashore on 5-4-1985 at Devbag was caught in bottom set gill net operated off Malwan on 1-4-1985 and suffered death due to suffocation caused by prolonged drowning in the water. The carcass was in a state of slight decomposition and the head was partly eaten away. Seven longitudinal narrow ridges of the carapace and five ridges on the plastron were clearly visible.

The live sea turtles if accidentally caught in the net are usually released back into the sea by the local fishermen as they venerate the turtle as an incarnation of Lord Vishnu. This practice, eventhough based on religious grounds, goes a long way in the conservational measures of this wild life. The incidental catches are occasionally landed and marketed.

HEAVY TAR BALL DEPOSITION ALONG VERAVAL COAST IN JULY, 1985*

Tar balls first seen in 1970 and increasing to 3-5 times since 1971, are becoming a common sight on the beaches of Veraval, particularly during the monsoon months. During late June, 1985, tar balls were seen washed ashore and in the first week of July, after the spring tide, the entire coast line of Veraval was strewn with large quantity of tar balls (Fig. 1). The average density of tar balls, as measured from the five distant sites along the beach was found to be 2.511 kg/m^2 which is far more than the density of 0.165 kg/m^2 recorded earlier by Dwivedi *et al.* (*Mahasagar*, **7** (1 & 2): 91-94, 1974) at Veraval but comparable with 2.375 kg/m^2 at Ghosabara, near Porbundar. However, their observations were subsequent to an oil tanker disaster which occurred near Porbundar, spilling 18,000 tonnes of oil in June, 1973. No such large scale accident or spillage has been reported during the past few years near Veraval.

Fig. 1. Tar balls washed at Veraval beach.

Most of the tar balls were 2-20 mm in diameter but some were large sized lumps measuring 100-120 mm in diameter. These large sized lumps were found with dense growth of epizoic goose barnacle *Lepas* sp. (60-135 *Lepas*/tar balls) ranging from 2 to 14.5 mm suggesting that these tar balls have been around long enough to become a substratum. Interestingly, associated with the tar balls were white, soft, disc shaped circular beads of plastic like material. Similar material was also found by Dwivedi *et al.* (but the chemical nature and probable origin of them are, however, unknown).

Although the tar balls are the nonvolatile residual part of the oil, and generally nontoxic, as seen by the profuse growth of the goose barnacles, their presence in the sea water affected the fishing activity at Veraval.

Fig. 2. Tar balls with goose barnacle *Lepas* sp.

During monsoon months the only fishing activity at Veraval is occasional gill-net fishing in the near shore waters during the day time but due to delayed monsoon during 1985 quite a few fishermen were regularly operating gill nets particularly for pomfrets. While fishing,

*Prepared by V. D. Deshmukh, Bombay Research Centre of CMFRI, Bombay and S. G. Raje, Veraval Research Centre of CMFRI, Veraval.

the floating tar balls got entangled in the surface gill-nets and when the nets were hauled up they were found blackened and unserviceable due to sticky melting tar. This caused considerable nuisance to the fishermen and most of them suspended fishing until the floating tar balls disappeared from the sea. The tar balls, spread on the beach also caused discomfort to the people visiting the sea shore.

Since no tanker accidents were reported along Gujarat coast and the quantity of tar balls is too large to account for any intertidal discharges or natural seepages, it is probable that these tar balls had arisen as a consequence of increased tanker traffic which passes from the Persian Gulf across the Arabian Sea and thus causing an environmental concern to the people associated with the marine activities at Veraval.

WIND-MILL PRODUCED ELECTRICITY FOR LIGHTING FISH FARM SHED AT MANDAPAM*

The concept of using wind energy for producing electricity is not new, though its application in India is of recent origin. Denmark, Norway, England and U.S.A. utilise the wind energy for power generation from early part of this century. Our coastal areas are rich in wind energy. But this replenishable energy source is not well utilised.

A low cost wind-mill battery charger was erected at Pillaimadam lagoon about 5 km from Mandapam Camp, on the southeast coast of India to produce electricity. The electricity thus generated is being utilised to light the still hut built in the Pillaimadam lagoon in connection with the culture of fishes.

A suitably modified 12 volt-dynamo was fitted at the top of a 8 m long palmyrah trunk planted 100 m from the shore in the Pillaimadam lagoon. A teak wood plank measuring 3 m long, 10 cm wide and 3 cm thick was used as the blade of the wind-mill. It was chiselled on opposite sides and fitted to the shaft of the dynamo so that maximum rotation was obtained. The blade and the dynamo could rotate as the wind direction changed. The dynamo was connected to a 12 volt battery with 18 plates kept in the lagoon hut.

The wind rotated the blade of the wind-mill to about 800–1000 R.P.M., activating the dynamo which in turn charged the battery. A cut out (Regulator 15 ohms) was connected to the battery which automatically disconnected the dynamo and the battery when more electricity was generated. Two or three batteries could be recharged using the same wind-mill. The system could be used to light 4 or 5 numbers of 6 volts bulbs. The direct current produced can be converted into alternate current by using a converter.

Fig. 1. The wind-mill erected at the fishfarm at Mandapam.

The total cost of the device was about Rs. 3,000/- but this can be reduced by 40% if reconditioned

*Prepared by R. S. Lal Mohan, Calicut Research Centre of CMFRI, Calicut.

materials are used instead of new ones as in the present case. The details of the cost incurred for the assembly is given below (1984 rates):

1.	Palmyrah trunk 8 m	Rs. 400.00
2.	Battery 12 volts (18 plates)	Rs. 1200.00
3.	Dynamo 12 volts	Rs. 750.00
4.	Regulator (cut out)	Rs. 75.00
5.	Wire, bulbs, holder etc.	Rs. 50.00
6.	Nuts and bolts	Rs. 25.00
7.	Other accessories	Rs. 150.00
8.	Paint	Rs. 25.00
9.	Labour and transport	Rs. 300.00
	Total	Rs. 2975.00

The wind velocity of the coastal area normally ranges from 0–10 km/h. During the northeast and southwest monsoon periods it may exceed 60 km/h. But the normal wind speed is sufficient to attain a R. P. M. of 300–600 which is sufficient to produce electricity.

ON THE UNUSUAL CATCH OF *PROTONIBEA DIACANTHUS* (LACÉPEDÉ) AT VERSOVA, BOMBAY*

Protonibea diacanthus (Lacépedé) locally known as 'Ghol' is one of the most commercially important fishes of northwest coast of India. In Bombay it is landed by both 'dol' netters and trawlers. Versova which is one of the major landing centres for 'dol' (bag) net boats, recorded a bumper catch of about five and a half tonnes of this fish. The catch was unloaded on 5th November, 1984 at about 0800 hrs from by a vessel named '*Jal Vihar*' Details of the operation are given below.

Fig. 1. 'Ghol' being landed by 'Jal Vihar' at Versova landing centre.

Fig. 2. 'Ghol' kept in the cold storage at Versova.

The boat which departed for fishing on 2–11–'84 stayed offshore for about four days. The catch of the first three days was brought by another carrier boat. The bumper catch of 'Ghol' was obtained only on the fourth day.

Sixteen 'Kodis' of 'Ghol' (one Kodi = 22 Nos.) were caught totalling 352 in number. The length frequency study showed that the size varied from 70 to

Name of the vessel	Gross tonnage	No. of nets operated	Depth of operation (m)	Time net shot (hr)	Time net hauled (hr)	Total catch (kg)	Catch per hour (kg)
Jal Vihar	11	2	30	2030	0100	5,432	1,207

*Prepared by S.K. Chakraborty and J.R. Dias, Bombay Research Centre of C.M.F.R.I., Bombay.

90 cm with an average weight of 15.43 kg. Majority of the fishes had their stomach gorged out. Other biological studies could not be done as the fishes were immediately despatched to Crawford Market where they were sold at a price ranging from Rs. 60 to 80 per fish realising about Rs. 4 to 5 a kg.

A very good fishery existed for 'Ghol' earlier which was declined sharply in the seventies.

The sudden appearance of bigger sized 'Ghol' off Bombay in relatively shallow water suggests the possibility of a potential bed in this area.

SUCCESSFUL LONG DISTANCE ROAD TRANSPORT OF GREEN MUSSEL FROM CALICUT TO PORT OKHA*

The seeds of green mussel were collected from coastal areas at Elathur (north of Calicut) in the morning hours of 26–11–'83, and after cleaning them thoroughly with sea water, without any prior conditioning, were kept in HDPE tanks of about 300–400 litre capacity. A total of 9,000 seeds were thus collected and transported to Port Okha.

A few seeds were transported in polythene bags with sea water kept in empty kerosene tins in the same manner as inland fish seeds are transported, with periodic oxygenation.

Oxygen was given for 5–7 minutes once in every 3–4 hrs of day time journey in HDPE tanks and once in every 24 hrs for the seeds packed in polythene bags. No journey was performed between 2000 hrs to 0600 hrs. At night, the faecal material was removed from all the containers by sieve, so that the debris was at a minimal level in the water. During the whole night period, the polythene bags were kept open and just before the commencement of the day time journey oxygen was supplied. An inverted funnel type of cover was specially fabricated to cover the HDPE tanks to minimise the spillage of water during the transport.

It was found that during transportation the mussels used to remain attached in groups to the tanks or one another by the byssus threads.

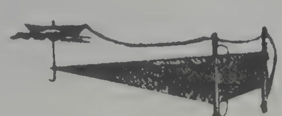
In HDPE containers the density of mussel was 3-4/1 and in polythene bags kept in kerosene tins it was 25/1. The latter type of packing seemed to be good as far as general condition and economics of transport were concerned. The journey started from Calicut on 26–11–'83 at 1000 hrs and ended at Port Okha on 1-12-'83 at 0230 hrs covering a linear distance of 2,300 km. The average size was 24.4 mm in length, 4.6 g in wet weight, 12.8 mm in width and 7.7 mm in breadth, and the transport used was a closed body insulated 10 tonner truck. Water was not changed during the entire journey period from Calicut to Okha.

On arrival at the destination, the mussel seeds were immediately kept in a collapsible 12 footer tank filled with seawater and allowed to rest for two days, after which a dozen or two of them were allowed to attach on separate coral stones. Very few of them tried to avoid the stones, though on second attempt they readily attached to them. The stones were then transported in a vessel and implanted in Gulf of Kutch Islands.

The experience gained in the process of transportation can go a long way in mass transplantation of mussel seeds or allied fish/shellfish seeds in the future.

We are thankful to Shri M. Kumaran and other scientists of Calicut Research Centre of CMFRI for the manifold help extended to us in this connection.

* Prepared by C. R. Trivedi, M. Bhaskaran, D. J. Wadher and F. D. Khhayya, Dept. of Fisheries, Okha, Gujarat.



REPORT ON BALEEN WHALE STRANDED ALONG MALLIPATINAM COAST, TANJORE DISTRICT *

A whale was reported to have been washed ashore on 18–5–'85 at 1530 hours along Pudupatinam sea shore near Adhiramapatinam (10° 16′N latitude; 79° 19′E longitude). It was possible to reach the place only on 28th as the information reached rather late.

*Reported by C. Kasinathan, Regional Centre of C.M.F.R.I., Mandapam Camp.

At the time of the inspection most of the flesh had been either removed or in a semi putrified condition. Even on the day of stranding, the fishermen reported that the animal was badly wounded and in a decaying condition. The presence of baleen plates indicated that it was a species of *Balaenoptera* (Baleen whale). The approximate weight of the whale stranded was estimated as 3,000 kg. The animal (snout to tip of caudal) measured 930 cm with a maximum of 151 cm of body height and 112 cm depth near the head region.

NEWS - INDIA AND OVERSEAS

NATIONAL SYMPOSIUM ON RESEARCH AND DEVELOPMENT IN MARINE FISHERIES

As part of the celebrations of forty years (1947–1987) of dedicated and fruitful work in marine fisheries research, the Central Marine Fisheries Research Institute, Cochin is organising a National Symposium on Research and Development in Marine Fisheries from 24–26 June, 1987 at Mandapam Camp, Ramnad District, Tamil Nadu. Those engaged in fisheries planning, programme implementation, research, education, extension, legislation and industry may send experience papers which are critical and pointedly relevant to the theme of the symposium.

The theme of the symposium is

— National fisheries policy, objectives and plans

— Research in marine fisheries management and development

— Capture and culture fisheries

— Marine fisheries development in the Central, State and Private sectors

— Fisheries technology

— Fisheries education, training and extension

— Management and conservation of marine fisheries resources

— Fisheries Acts, rules and regulations

— Marine fisheries development – an outlook for 21st century.

The authors may register the titles of the papers by 15th April, 1987 in the prescribed registration form and also enclose the abstract in duplicate, not exceeding one page. Full papers in duplicate, may be sent so as to reach by 15th May, 1987. For more details write to the General Convener, National Symposium on Research and Development in Marine Fisheries, Central Marine Fisheries Research Institute, P. B. No. 2704, Cochin - 682 031.

AQUACULTURE EUROPE 1987

The European Aquaculture Society (formerly European Mariculture Society), proposes to hold an International Aquaculture Conference and Trade Exhibition, 'AQUACULTURE EUROPE 1987' at Amsterdam, Netherlands from 2–5 June, 1987. The programme encompasses invited review papers, oral and poster presentation, panel sessions as well as session devoted to aquaculture film/slide shows. For further details please contact, EAS, Prinses, Elisabethlaan 69, B-8401 Bredene, Belgium.

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